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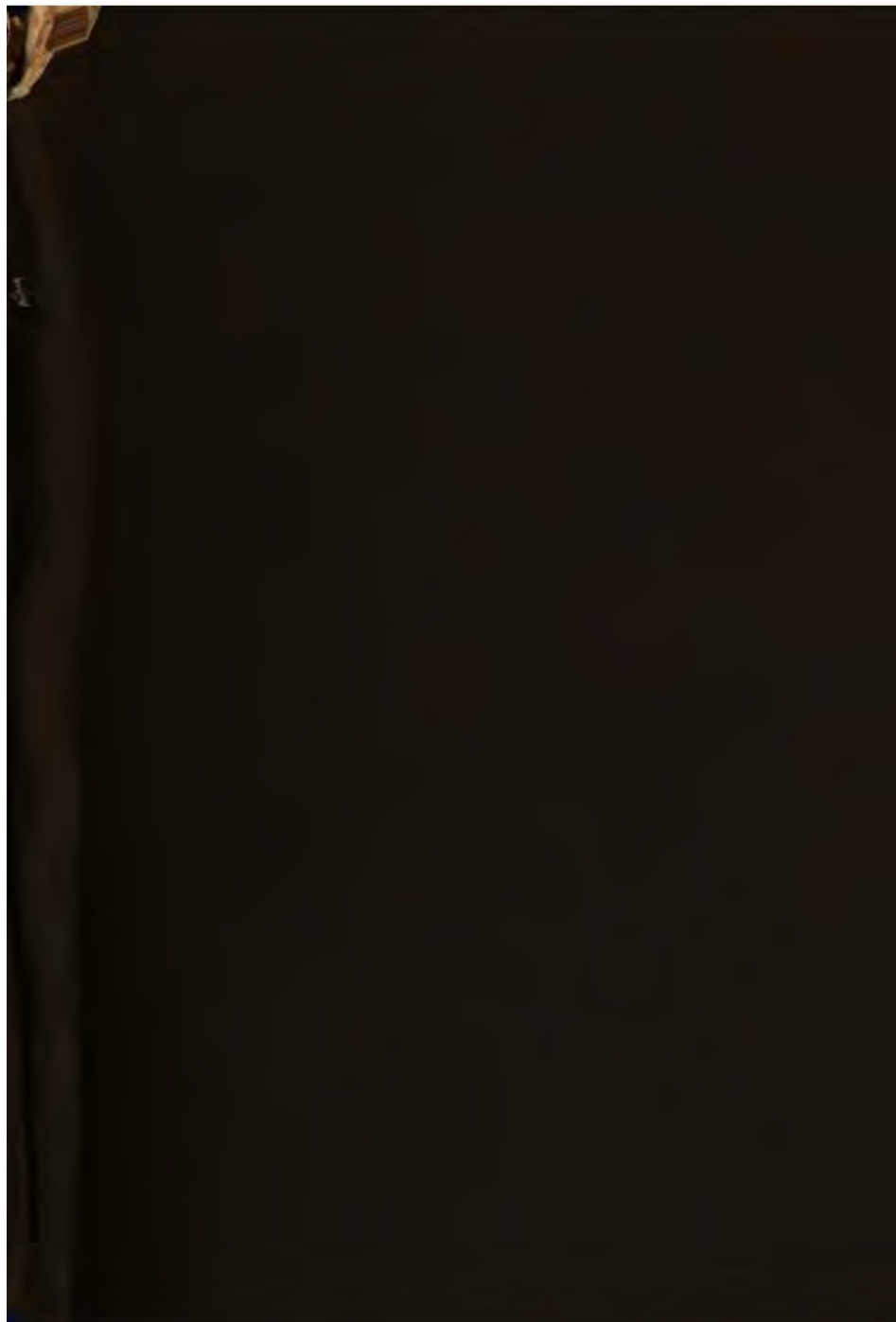
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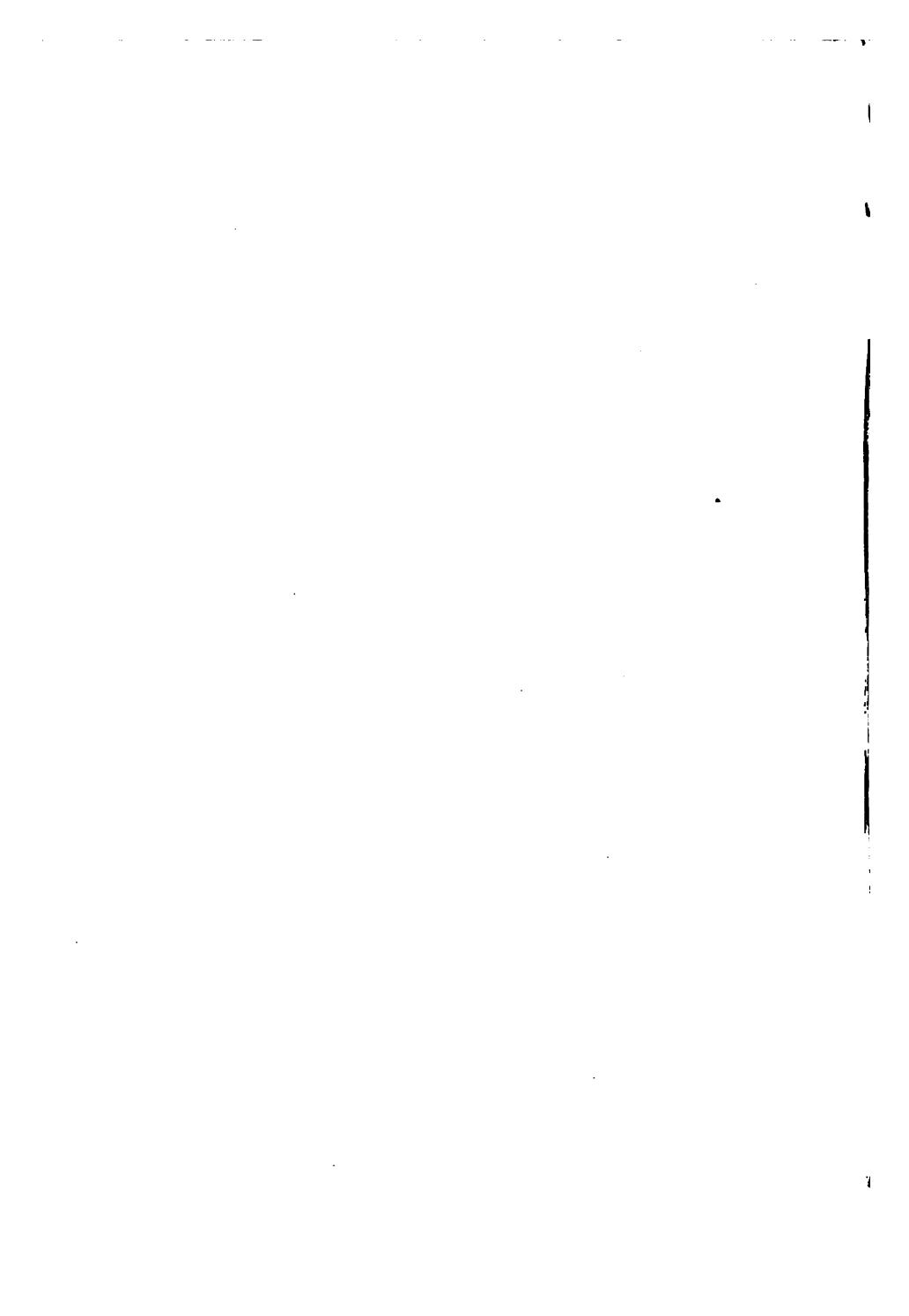


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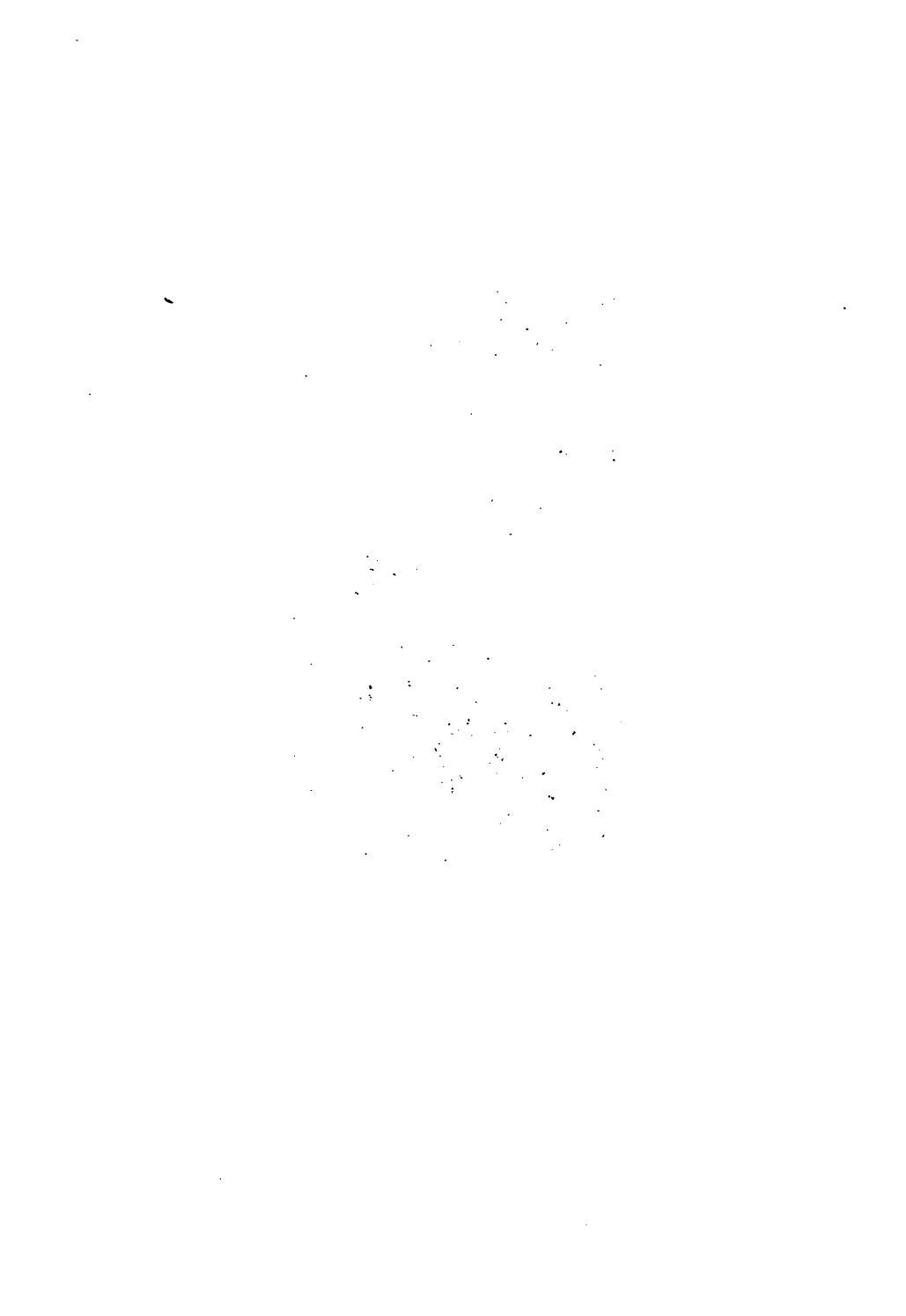
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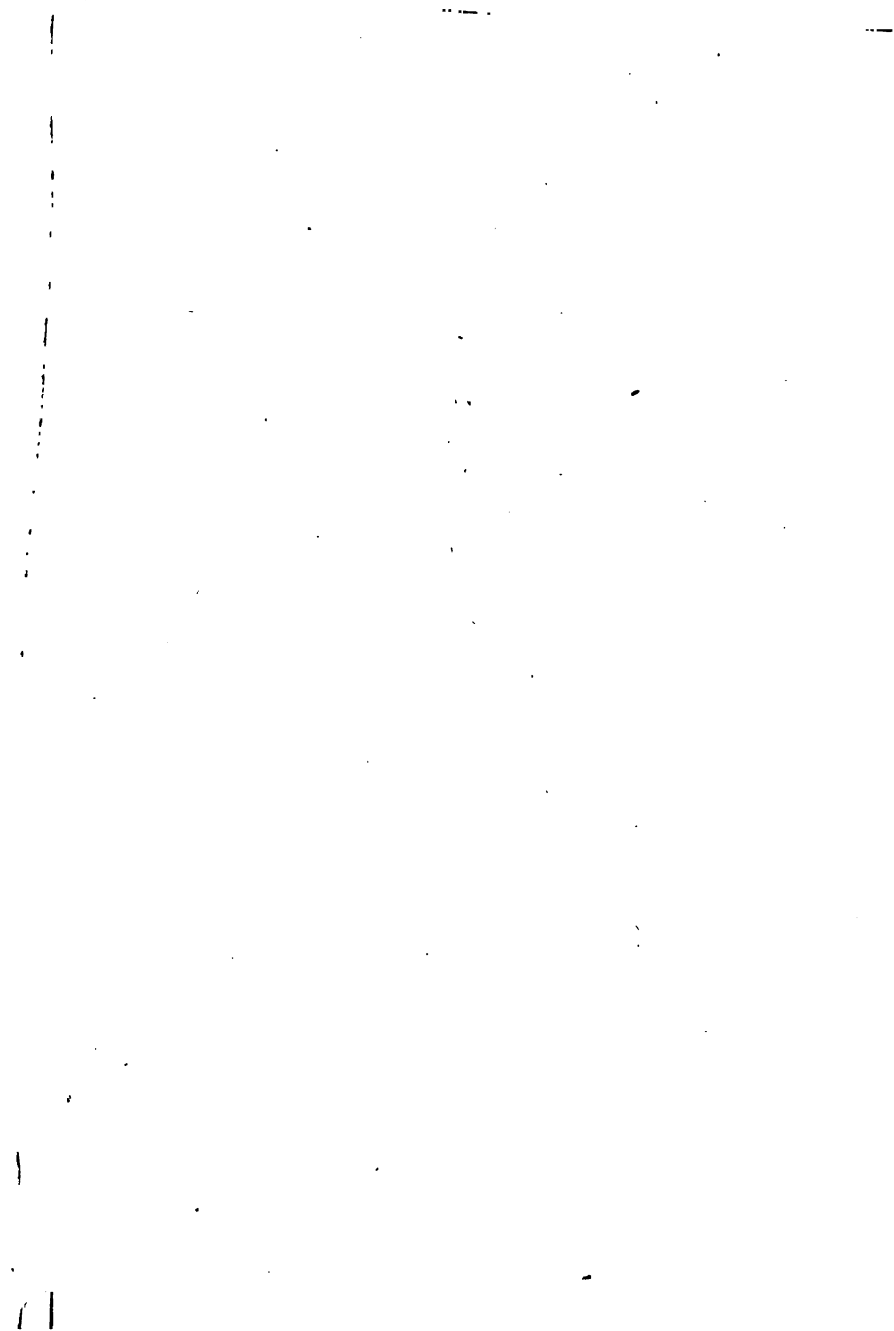


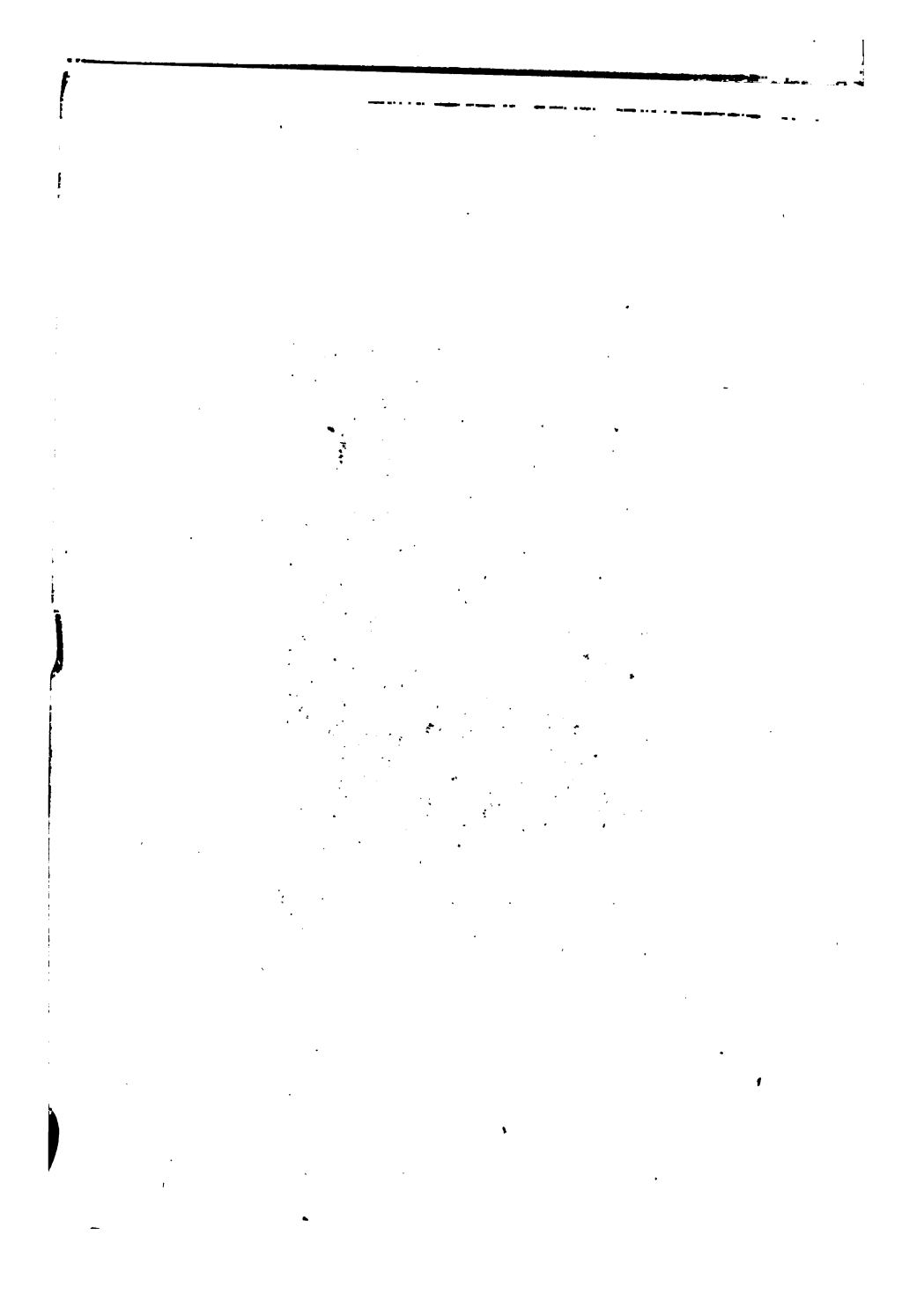
IMPROVEMENT
OF
THE CEREALS





Patrick Shirreff





IMPROVEMENT
OF
THE CEREALS

AND
AN ESSAY ON THE WHEAT-FLY

BY
PATRICK SHIRREFF

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P R E F A C E.

HAVING frequently been asked to accept of a testimonial for having raised and introduced new varieties of grain, this high compliment was at first declined on account of my advanced age; but at length I acceded to the wish of my friends, on condition that the money raised for the testimonial should be set aside for improving the cereals in time to come. But this matter came to an end by having placed in my hand a bank receipt, with a verbal communication that there was much difficulty in arranging a proper plan for disposing of the fund according to the wishes I had expressed.

From the feeling existing amongst farmers, it may be doubted if the time has arrived for ex-

pecting them to engage in the improvement of the cereals, and in all probability better results would arise by first pointing out how improvement was likely to be brought about.

I therefore resolved to prepare a short account of some of my experiences while engaged in improving the cereals, and to present a copy to each of the subscribers to my testimonial. Not pretending to scientific accuracy of description, my chief aim has been truthfulness of my details.

PATRICK SHIRREFF.

HADDINGTON, *11th March 1873.*

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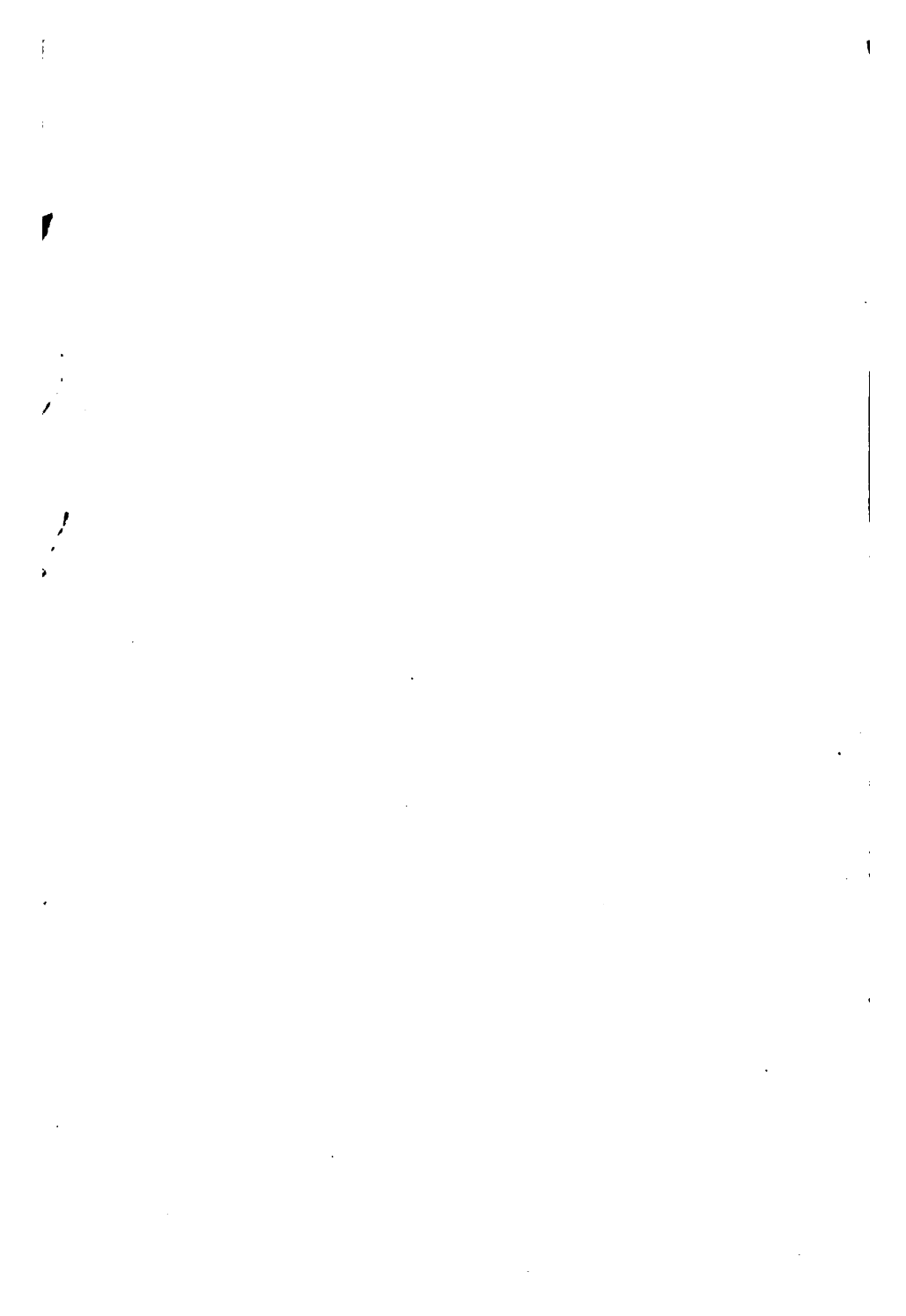
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ix

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Stephen Wilson, Aberdeen.
John White, Garleton.
James Wilson, Erskine.
John Wilson, Edington Mains.



LIST OF ILLUSTRATIONS.

<p>PLATE I.</p> <p>Fig. 1. Rachis.</p> <p>„ 2. Capsule.</p> <p>„ 3. Spikelet.</p> <p>„ 4. Style and Anthers.</p> <p>„ 5. Blossom without the Chaff (after Balfour).</p> <p>„ 6. Ear prepared for crossing.</p>	<p><i>Opposite page 18</i></p>
<p>PLATE II.</p> <p>Fig. 1. King Richard.</p> <p>„ 2. Shirreff's Bearded White.</p> <p>„ 3. Talavera.</p>	<p>30</p>
<p>PLATE III.</p> <p>Fig. 1. Ear of thinly-planted crop.</p> <p>„ 2. Ear of thickly-planted crop.</p> <p>„ 3. Ear of medium-planted crop.</p>	<p>56</p>
<p>PLATE IV.</p> <p>Fig. 1*. Ear from nature.</p> <p>„ 1. Opposite side of same ear destroyed by the wheat-fly.</p> <p>„ 2. Ear bursting the sheath.</p>	<p>106</p>

CEREALS.

My experiences in the improvement of the cereals arose from the following circumstance. When walking over a field of wheat on the farm of Mungoswells, in the county of Haddington, in the spring of 1819, a green spreading plant attracted my notice, the crop then looking miserable from the effects of a severe winter; and next day measures were taken to invigorate its growth by removing the surrounding vegetation and applying manure to the roots. In the course of summer several stalks were cut down by hares; but notwithstanding this loss to the plant, sixty-three ears were gathered from it at harvest, yielding 2473 grains, which were dibbled in the following autumn at wide intervals. For

the two succeeding seasons the accumulating produce was sown broadcast, and the fourth harvest of the original plant amounted to about forty-two quarters of grain fit for seed; and proving to be a new variety, it was named Mungoswells wheat. But as frequently happens with farm plants, the name was not long of being changed; and this wheat has been sold in the Corn Exchange of Haddington under the names of East Barns, Murray's, Fraser's, Lady Hall, and Allias wheat.

The grain of Mungoswells wheat is lighter in colour than Hunter's, not so long, but equal, if not superior, in weight and quality to that well-known variety. The straw is perhaps a little taller than Hunter's, and not so apt to lodge, and the tillering properties of the variety are great. This wheat is extensively grown on several farms in East Lothian at the present time, but not always under its true name.

In the summer of 1824, a tall oat-plant was observed in a field of this cereal on the farm of Mungoswells, and its seeds, in the following season, were included in a collection of named

varieties grown with a view of making myself acquainted with their distinguishing characteristics. At harvest the crop from the seeds of the tall plant, which I had selected in the previous summer, proved to be the tallest in the collection ; and this variety I raised and introduced to public notice under the name of the Hopetoun oat. The grain is longer than the potato-oat, and generally has a streak of red on the concave side of the seed ; it weighs well, and produces meal unequalled in quality and whiteness. When grown under a parity of circumstances, the straw is from six to eight inches taller than the potato-oat. The stalks grow very irregular in height ; and this peculiarity of habit is apt to give a deceptive appearance of thinness to the crop. Soon after the discovery of this oat, it was adopted as a farm crop in many of the oat-growing districts of Britain, in countries on the Baltic, and in sections of North America. The Hopetoun oat is still cultivated in many parts of Scotland, and in East Lothian a seed premium is given for this variety up to the present time.

In the autumn of 1832, a fine ear of wheat was found on the farm of Drem, which adjoins Mungoswells. This ear originally contained one hundred and two grains, but three of them had dropped from the chaff before coming into my possession, and from the remaining ninety-nine I raised the Hopetoun wheat at Mungoswells. The seeds were carefully removed from the original ear, which was afterwards exhibited in the Stirling Agricultural Museum. The grain is rather large, white, and heavy; the ear is handsome, and its chaff white. The straw is about two inches taller than Hunter's, larger in circumference, and growing so equal in length that this habit of the plant leads to a deceptive appearance of thickness of crop, and, with superficial observers, to disappointment in the yield of grain. This variety found its way into many of the wheat-growing districts of Britain, and over a wide range of country and climate. It succeeded better than some of the white varieties originated in Scotland, which become so high-coloured when grown in the south of England as not to be classed in that country as white

wheats. In the west of Scotland the name of this variety has been changed into White Hunter's.

The next cereal which I selected, raised, and introduced into field-practice, was the Shirreff oat, which ripens early, and is reputed to be very prolific. The seeds are streaked with red on the concave side, like the Hopetoun oat; they are long-shaped, and weigh light in the bushel. The straw attains to about the same height as the Hopetoun oat, but without its irregularity of growth. At the present time, the Shirreff oat is seldom to be met with in Haddington Corn Exchange; but it can generally be found in the markets of Dalkeith and Kelso, and often in the latter place under the old *sobriquet* of "Make-him-rich."

Hitherto I had followed the improvement of the cereals by fits and starts on the spur of the moment; but in 1856 something like a continued and systematic investigation of the subject was begun. Wheat-fields on both sides of the Tweed, and more especially in East Lothian, were examined, and many ears differing in appearance from

the ears of the general crops were selected for propagation. My experimental trial-plot of wheat for 1857 contained plants from the seeds of more than seventy years, which had been selected during the previous year. The crops were harvested with care—a small portion of each kind being placed under glass as soon as the straw was severed from the ground, and their grains examined when they had become thoroughly dry. Such samples as appeared to be promising were reserved for further trial, and all others were cast aside. From the numerous new varieties of the first year's collection three kinds only were propagated and added to the seeds of the farm, all of them being from ears picked up in East Lothian. The first of the three offered to the public was named Shirreff's Bearded Red, which has long, slender, wiry straw, and a rather thin-set, red-chaffed, bearded ear, the grain being red, long, and of the finest quality. This variety was found in a field of Hunter's wheat on the farm of Tynefield, parish of Dunbar, and may be regarded as a type of the Old Red Lammas. The second of these wheats offered to the public

was Shirreff's Bearded White, which has white bearded chaff, and symmetrical ear supported on tall, good straw. The seeds are small, round, and pearly-looking, heavy in the bushel, and yield flour of fine colour. The third variety was Pringle's wheat, which is characterised by long stout straw, terminating in a large, white-chaffed, bearded ear, the grain being oval, and in colour a creamy white.

In such an investigation as I had entered upon, it soon became evident to myself that without strict superintendence in some of the processes, success was not likely to be attained. It was also found that the time required for sowing, harvesting, separating the grain from the straw, and dressing the crops, rendered it advisable to limit the space allotted to the growing of each variety, and also to restrict the number of kinds on trial. It was also thought that a collection of the named wheats in cultivation would assist the inquiry; and when all the arrangements were completed, my comparative trial-plot of wheat might be described thus:—On a field cropped

with wheat, named and unnamed varieties were grown in parallel rows, from twelve to fifteen feet long, and from nine to twelve inches asunder, with a foot-path a yard wide surrounding the whole plot. The crops were kept off the foot-path by a line of tarred twine, which was afterwards used in binding the sheaves. Small bundles of ears of each kind were dried under glass, and their grains preserved for comparison and future reference. From time to time notes were made regarding each kind, such as their time of ripening, length of straw, &c. &c. By such means the new varieties could be more readily distinguished from the old, and misnaming detected, as well as the effects of soils and seasons upon the different kinds approximated. The surface of the plot was formed into ridgelets two inches deep by means of a line and hand-hoe. Then commencing on one side, the seeds were placed by the hand at a given thickness, and each variety covered with earth before another was planted. By proceeding in this manner the seeds were placed in the soil at nearly equal depths and distances, and

the different varieties kept from intermixing in the process of sowing. By placing a few stuffed cat-skins partially covered with twigs up and down the plot after the seeds had been sown, few birds ventured to disturb the seeds. In fixing on a situation for a comparative trial-plot, avoid if possible the proximity of trees, hedges, and other objects frequented by birds. See that the soil is not too manurially rich, and not likely to be infested with insects which are known to attack the wheat plant. A soil which has long been under cultivation, and from which a potato crop has just been removed, will be found suitable. Two rows of each variety will show its distinctive characteristics better than one.

Some particulars connected with my crops of 1859 deserve to be noticed at this place. The arrangements of the comparative trial-plot were not completed at this time ; and fourteen new varieties had been sown adjoining each other on parallel spaces fifty yards in length and varying width, so arranged that a red and a white chaffed variety alternated, the whole being surrounded with Hopetoun wheat, which was grown as a

farm crop. In the year following, three of these varieties were propagated upon a pretty extensive scale. Shirreff's Bearded Red in 1860 occupied about twelve imperial acres; and at harvest, over the whole extent there were observable a few white-chaffed ears, which were picked out by women when the crop was being carried from the stack to the thrashing-machine. In the crop of Shirreff's Bearded White there appeared a very few red-chaffed ears, which were picked out when the crop was being carried from the field to the stack. In the case of Pringle's wheat, no mixture of ears could be noticed. The removal of the mixed ears was followed by good results, as neither of the varieties as sold to the public was considered to be a mixed kind; and when grown with ordinary care, they are found at the present time to be as genuine as most of the wheats in cultivation. Hitherto I had entertained doubts about varieties crossing when growing in close proximity, but in the cases just described the evidence could not be easily set aside.

The trial-plot of 1861 contained plants from the seeds of eighty-four ears, which had been selected from the mixed crops alluded to of 1860; and

to guard against mistakes, all the manipulations necessary for their propagation were performed by myself. Unfortunately, the soil was so infested by insects that nine-tenths of the plants perished under their attacks and other causes, and the few which survived were so beaten down by wind and rain that the quality of the grain could not be satisfactorily ascertained. On a general view, the seeds of the white-chaffed ears selected from the crop of Shirreff's Bearded Red had seeds resembling the grain of that variety; and the red-chaffed ears from the crop of Shirreff's Bearded White had seeds resembling its grain. But in the descendants of both chaffs there was diversity in the form of the ear; in the size, form, and colour of the seeds; and also in the straw. From both of these sources several good varieties were added to my collection; but as none of them appeared to be superior to Shirreff's Bearded White, they were not pressed on the notice of the public.

Up to this time many ears of wheat had reached me from persons residing at a distance, and often unknown to me. The seeds of such ears found a place in my experimental plots; and

to such parties I offer thanks for their kind and encouraging attentions.

In 1862, an attempt was made to improve oats. Fields of this cereal growing in the neighbourhood of Haddington were examined, and ears selected with the view of their seeds being propagated. In the spring of the following year, the seeds of these ears were grown contiguous in my experimental plot, as has been described in the case of wheats, and the following conclusions were drawn from the results of the crops: That several of the selections were identical with named kinds, and that others were inferior to the oats in common cultivation. The most promising kinds were included in my comparative trial-plot in 1864, along with eighteen named varieties. Ultimately, four of the selections were extensively propagated, which I sold to the public under the following names:

Early Fellow is perhaps the earliest variety of the species cultivated in the Lothians, ripening five or six days before the potato-oat, and has straw a few inches taller. The grain is heavier, shorter, plumper, and has a thicker husk than

the potato-oat—the seeds of both being equally liable to shed when the crop is allowed to become too ripe before being cut down.*

Fine Fellow is earlier than the potato-oat, and exceeds it in length of straw by eight or ten inches. The grain is short and plump, like the potato variety. The husk is slightly cream-coloured, with a redder streak on the concave side than the Hopetoun oat. This variety is generally double-seeded, having a large and a small seed attached together and enveloped in the same chaff-scales.

Long Fellow is the tallest of the Fellow family, and perhaps has longer straw than any oat in cultivation, and ripens a day or two later than the potato-oat. The straw is finer in quality, firmer in texture, freer from leaf, less injured by wet weather, and is generally a foot taller than the potato-oat. The grain has a silvery long thin husk well filled with kernel, and suited either for milling purposes or horse-feed.

* In 1871, *Early Fellow* was exhibited at seed-shows in Dumfriesshire in the class of potato-oats, and was awarded three first premiums under this counterfeit name.

Long Fellow is constitutionally adapted to the climate of Britain. Being narrow in leaf, and slow of growth in the early part of the season, the energies of the plant seem to be husbanded until the ears appear, when the stalks push out and continue to lengthen until the crop is ripe. With these peculiarities of the plant's growth, the early kneeing or lodging of the crop seldom takes place, and in this respect is a contrast to the Georgian oat, now named Canadian oat, with early habit of growth, broad leaf, and inferior quality of straw. In my trial-plot for 1867, when much rain fell during summer, and also in 1869, when the summer was very dry, the grain of Long Fellow was both years the best in my collection.

With exception of a single occasion, noticed in the sequel, I avoided testing the relative productiveness of varieties, from an idea that my evidence on this point might have little weight with others, from being the raiser and introducer of so many new kinds. Being anxious to learn something of the merits of my new varieties of oats, inquiries were made at many individuals who had a supply of seed from me. But, as a

general rule, satisfaction was expressed at the results obtained, and that the variety which each person had grown was considered the best oat in cultivation. It, however, turned out that few individuals had grown more than one of the new oats as a first adventure ; but this puffing, which did little or no injury to individuals, was the means of procuring circulation for each of the new varieties. There was an exception of one individual who favoured me with the following statement, with liberty to use it :—

“DODRIDGE, FORD, DALKEITH,
March 9, 1869.

“DEAR SIR,—You ask for my opinion of your new varieties of oats. I have grown all the three sorts, Early Fellow, Long Fellow, and Fine Fellow, for two years ; and the first year, 1867, I tested them carefully against one another, and the result was, that while thinking them all valuable varieties, I so far preferred Fine Fellow that I sowed in 1868 thirty-nine Scotch acres of them against five acres of Early Fellow and eleven acres of Long Fellow.

(Signed) “ARCHIBALD AINSLIE.”

The experiments of a single season cannot be taken to determine the values of varieties of oats, and the worth of the respective members of the Fellow family is perhaps still undetermined.

The fourth selected variety of oats, and raised for field-practice at the same time as the three Fellows, appeared to be so like the well-known Early Angus variety, that it was sold under that name. At seed competitions held at Haddington and Dalkeith, this variety of my raising has repeatedly been awarded first-class premiums; and on one occasion, at Dalkeith, carried off the Highland Society's Medal as the best oat of the competition, which included several old favourite kinds.

In 1867, when all the varieties of the oat, from the wetness of the season, may be supposed to have reached their maximum length of straw, the following average heights were obtained from the crops of my comparative trial-plot: Early Angus, 4 ft. 6 in.; Strathallan, 4 ft. 6 in.; Red Oat, 4 ft. 7 in.; Sandy, 4 ft. 7 in.; Birlie, 4 ft. 4 in.; Potato, 4 ft. 3 in.; Early Fellow,

4 ft. 4 in. ; Shirreff, 4 ft. 7 in. ; Fine Fellow, 4 ft. 11 in. ; Hopetoun, 4 ft. 9 in. ; Long Fellow, 5 ft. 1 in. ; Barbachly, 4 ft. 7 in. ; Shandwich, 4 ft. 6 in. ; Kildrummie, 4 ft. 7 in. ; Waterloo, 4 ft. 6 in. ; English Barley, 4 ft. 3 in. ; Scotch Barley, 4 ft. 3 in. ; Black Tartarian, 4 ft. 6 in. ; and White Tartarian, 4 ft. 6 in.

In the dry summer of 1869, the following are some of the measurements obtained from my trial-plot: Potato-oat, 3 ft. 6 in. ; Early Fellow, 3 ft. 9 in. ; Fine Fellow, 4 ft. ; Long Fellow, 4 ft. 6 in. ; and Sandy, 3 ft. 9 in.

Many people believe that some plants can be altered by skilful treatment, but my experience has tended to show that there is no way of permanently improving a species but by new varieties. In support of this view of plant improving, gardeners can point to hosts of new and improved varieties of fruits, vegetables, and flowers ; while in corroboration, farmers can bring forward the Chevalier barley, Swede turnip, Italian rye-grass, and the Alsike clover. To this principle of improvement the cereals form no exception ; and the small amelioration

which they have undergone in this age of progress may fairly be attributed to the apathy of corn-growers to this department of agriculture.

New varieties of the cereals can usually be obtained from three sources—from crossing, from natural sports, and from foreign countries. Wheat will be taken to illustrate the first division of this subject, which will be the more easily understood by a description of some parts of the plant. The ear is formed at the termination of the stalk, and consists of a rachis or backbone, with two rows of notches placed opposite to each other, which support a spikelet. A spikelet consists of all the seeds attached to one notch, and which are found to vary in number according to the circumstances in which the plant may have been grown. The chaff forms the capsule, and it consists of two valves, which, on the ear first appearing, closely adhere together; but they recede with the growth of the plant, so as to afford room for the blossom inside expanding, and performing its functions. The blossom is composed of male and female organs of reproduction; the latter consisting of stigma,

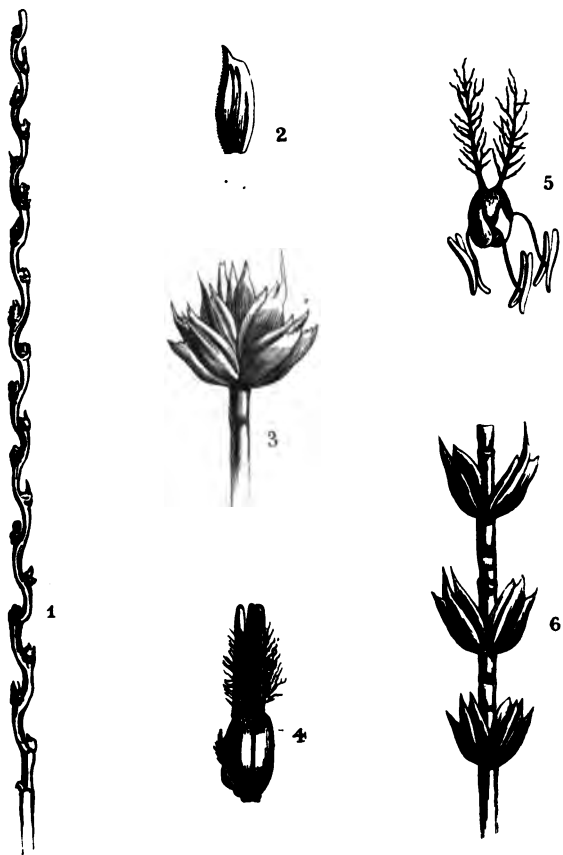


PLATE 1.—1, *Rachis*; 2, *Capsule*; 3, *Spikelet*; 4, *Style and Anthers*; 5, *Blossom without the Chaff*—after Balfour; 6, *Ear prepared for crossing*.

style, and ovary—and the former of three anthers, which contain the pollen or fecundating powder, and are supported on filaments. When the blossom is about to unfold, and the weather is fine, the valves of the chaff may be seen to gape wide open; the stigma then resembles two feathery substances sparkling with viscid moisture, and spread out in opposite directions. By a sudden lengthening of the filaments, the anthers are raised up when they burst, and with a quivering motion dust the stigma with their ripe pollen, which is conveyed by the viscid moisture to the ovary, and the empty hulls of the anthers are carried out of the floret by the still farther lengthening of the filaments, which are connected with two globular vessels, botanically named glumellules, at the bottom of the ovary, and furnishes the filaments with the means of lengthening and quivering. On the process of fecundation being completed, the valves of the chaff return to their former position, and the hulls of the anthers are left dangling on the outside; then the female organs begin to wither, and the seed to form. The ear in calm weather, when

studded with the hulls of the ejected anthers, is a graceful object, and with gaping chaff, glittering stigma, and quivering anthers, is suggestive of vegetable gladness. It is usual for farmers to consider wheat to be in bloom when the hulls of the anthers appear on the outside of the chaff, and to dread the effects of wind or rain at this stage of the plant's growth on the ultimate productiveness of the crop; but the hulls of the anthers being in such a position is evidence of the process of fecundation being at an end, and which a change of weather is not likely to undo. But the opening of the chaff and ejection of the anthers take place only in fine weather, and are not essential to fecundation, a seed and decaying anthers being sometimes found in the same capsule. The anthers are not unfrequently fixed within the floret by the operations of the wheat-fly, an insect which will be more particularly noticed in the sequel. With unfavourable weather the valves of the capsules do not perceptibly open, and fecundation takes place within the capsule. I have on different occasions wrapped a thread round a portion of ears just

escaped from the sheath, so that the chaff-scales could not open naturally, and on the removal of the threads some weeks afterwards, a seed and withered anthers were found in every capsule which had been so treated. The rapid lengthening of the filaments and the dusting of the stigma with pollen, and the throwing out of the hulls of the anthers, are properties common to nearly all the native grasses of Britain. The hulls of the anthers are generally yellow, but sometimes they are purple.

The crossing of cereals consists of fecundating the stigma of one variety with the pollen of another; and in the case of wheat, there is so little difficulty in the process that it may be successfully carried out by persons unacquainted with botany, after getting one or two lessons. Before commencing to cross, consider what properties the new variety is wished to inherit, and fix upon such kinds as possess in the highest degree the desired properties. Commence operations by shortening the ear of the seed, or female breeder, a day or two after being clear of the sheath, remove every alternate spikelet, and

leave only the two outside capsules on a notch. An ear so prepared may consist of four or six notches, with eight or twelve capsules; and the mutilations which the ear has undergone will facilitate the after-manipulations, and prevent the upper florets from shedding their pollen on the florets under operation. Having proceeded so far with the seed parent, bring forward an ear or two of the pollen parent about the same stage of forwardness. Then open the chaff-scales of the female breeder, and having removed the anthers out of the capsule, replace them with anthers taken from the male breeder, then close the chaff-scales by a slight pressure of the fingers. In removing the anthers of the seed parent, care ought to be taken not to break them, as their pollen may fall upon the stigma, and in such a case the resulting seed may not produce a hybrid plant; but little nicety need be used in changing the anthers of the pollen parent, as the pollen dust retains its fertilising properties for a considerable period, and the bruising of the anthers is not unfavourable to fecundation. The process of crossing is best carried out by two

persons acting in concert, the one confining his attention to holding open the chaff-scales of the seed parent, and the other to the removal and the replacing of the anthers, which can be readily done by seizing the clusters of anthers with small pincers. Before leaving the scene of operations, fix the ear operated upon to a stake, and envelop it in wire-gauze, which will effectually protect the crossed capsules from being ruffled by one ear rubbing against another during wind, and from birds when the seeds are formed. With such precautions the crossing of cereals may take place in any situation, and I have carried it out in a town garden to a successful end. The season for crossing may be extended for weeks by selecting the latest ears, and still further by cutting over near to the ground a portion of the stalks of both breeders, and thereby getting a late crop of ears. The seeds obtained by crossing are generally little better than abortions in appearance; and the properties of the plants which arise from them cannot be ascertained without two or three reproductions from seed, many more being necessary to test the

effects of climate. As soon as the grains obtained by crossing become dry, place them in thumb-pots in a garden, protecting them from birds and insects by sprigs of furze spread on the surface and by a few coal-ashes in the bottom, and afterwards remove the plants to where they are intended to be grown. This plan prevents the intermixing of kinds, and generally the attacks of insects residing in the soil or frequenting the air in the early stages of the plants' growth.

The inflorescence of oats and barley being identical with wheat, the crossing of these cereals can be effected in like manner as with wheat. The valves of their inflorescence also occasionally open in fine weather, and the hulls of the anthers are also ejected ; but the nature of the coverings which protect their organs of reproduction require such nicety of manipulation, that attempts have seldom been made to cross with them.

After repeated attempts to cross oats, I at length succeeded in getting one seed which produced a plant in the following season. About this time my attention was chiefly devoted to the

wheat plant, and my cross-bred oats were consequently somewhat neglected. From the circumstances under which these oats were grown, the straw of the third crop proved to be short and weak, the whole produce at harvest being comprised of four small sheaves, which were given in charge to a young person. During a wet harvest the sheaves stood long exposed to the weather, and at length I learned that the lad's father had treated his young horses to them. In 1870, more than a dozen of florets of oats in my experimental plot were attempted to be crossed by three young friends who wished to acquire the art of crossing cereals. Everything looked favourable up to the approach of harvest; but at this time a workman by mistake smashed up a portion of the crops on my experimental plot, mixing different kinds of oats and wheat—including the hybridised oats—in an undistinguishable mass. In 1871, four seeds of oats were planted together in a garden, with a view of crossing—the soil being free, rich, and well sheltered. The plants looked healthy for a time; but they were attacked by the disease

known as *tulip root*, and did not produce a single floret.

The published accounts of the crossings with cereals in Britain are meagre and disappointing. Some of the attempts appear to have been made more with a view of ascertaining if the crossing of such plants was practicable than of improving the species—the external features of the ear engaging more attention than the grain, which is the most important part of the plant.

Mr Knight, the celebrated horticulturist, was perhaps the first individual in Britain known to have crossed wheat. The following extract is taken from his account of the matter: "I readily obtained as many varieties as I wished by merely sowing the different kinds together; for the structure of the blossom of this plant, unlike that of the pea, freely admits that of advantageous farina, and is thereby very liable to sport varieties. Some of those I obtained were excellent, others very bad, and none of them permanent. By separating the best varieties a most abundant crop was produced, but in quality was not equal to the quantity; and all

the discarded varieties again and again made their appearance. It appeared to me an extraordinary circumstance that in the years 1795 and 1796, when almost the whole corn of the island was blighted, the varieties thus obtained only escaped in this neighbourhood when sown on different soils and situations."

At the London International Exhibition of 1851, ears of hybrid wheat were shown by Mr Maund and Mr Raynbird. Several of the ears might have been regarded as curiosities ; and, while proving the possibility of crossing varieties, there was no evidence of improvement having been effected. In a letter published in 'The Gardeners' Chronicle,' Mr Maund alludes to his difficulties in crossing agricultural plants, thus : "In some instances not more than one in ten of my experiments have been completely satisfactory." Mr Raynbird competed for a medal given by the Highland Society of Scotland, with a cross-bred wheat named Raynbird's Hybrid, and the medium gold medal was awarded to him. In his essay to the Society the new variety was described as a

coarse red wheat, which was obtained by fertilising Piper's Thickset with pollen from Hoptoun wheat. Mr Raynbird was perhaps the first person who offered a hybrid or cross-bred wheat to the notice of British farmers; but the coarseness of the grain was against its favourable reception. My experience with a small quantity of this wheat, kindly supplied by Mr Raynbird, enabled me to testify to the coarseness of the grain, and that the variety reproduced with constancy in my experimental plot.

One of my first attempts at crossing was made with April and Talavera varieties, the latter being the pollen parent. The plant from this cross-fecundation appeared to be an intermediate between the breeders, and all its seeds were sent to a gentleman residing about five hundred miles distant. An opportunity of seeing a crop from the artificially impregnated seed did not occur until nearly three years afterwards, and then described by me as follows: "It was found to consist of many varieties; nine-tenths of the capsules proved barren, and many of the seeds seemed shrivelled abor-

tions void of vitality, and the whole race to be verging towards extinction." The crop had been sown late in spring, and at the time of my visit it was not long out of bloom, and altogether looked so miserable that it was agreed not to sow it again.* Between my first and second attempts at crossing wheat nearly twenty years intervened, the process which I at first followed being slow and uncertain. Without assistance, the valves of the chaff were opened and the anthers removed one by one with the point of a needle. Three or four days afterwards, according to the state of the weather, the valves of the chaff were again opened, and the stigma touched with a camel-hair brush covered with pollen taken from the anthers of the male breeder. From the frequent opening and clos-

* Mr Darwin, in his important work on 'Animals and Plants under Domestication,' has noticed my first account of wheat-crossing; and, should his publication undergo another edition, I beg that my account may be omitted, being now satisfied that the state of the crop at the time of my visit to it was chiefly owing to the ravages of the wheat-fly, which my hurried inspection prevented me detecting at the time. By mistake, I stated the crossing to have been with Hopetoun instead of April.

ing of the chaff-valves, they frequently dropped off after fecundation had been effected; and scarcely one attempt in ten ended successfully, until the method described at page 21 was adopted, which so changed matters that three attempts out of four proved successful.

For some time my cross-fecundations produced nothing very striking, until a variety in my comparative trial-plot attracted notice from its size of ear, and the length and strength of its straw. When ripe, the grain was found to be fine in quality; and it was decided to raise a stock from it for field-practice. This variety is known as King Richard, and was obtained from fecundating Shirreff's Bearded White, which has small round seeds, with pollen from Talavera, which has large grain of the finest quality; the cross having been made with the view of enlarging the seeds of Shirreff's Bearded White. In several properties King Richard has been found to surpass both parents. The straw is longer and stouter than the straw of the female breeder, and the chaff is beardless—the form of the ear being a medium of both parents. The grain in

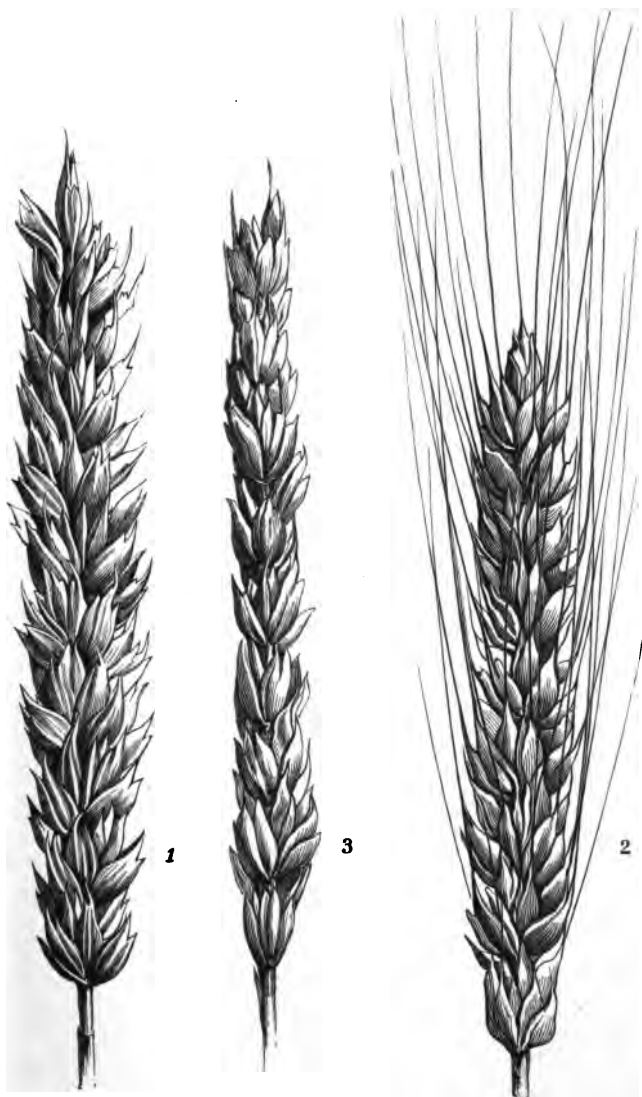


PLATE II.—1, *King Richard*; 2, *Shirreff's Bearded White*;
3, *Talavera*.

size and form approaches near to the grain of Talavera, and in quality is superior to the parents. The tillering properties of the variety are not very great, and in this respect it is also a medium of the parents; but in the early stages of growth the habit of the plant is upright and not spreading, which renders the defect more apparent than real. In the fourth reproduction a few bearded ears appeared in the general crop, often similar in form and with similar grain to King Richard. These mixed ears in all probability are owing to the hybridous origin of King Richard, and are not likely to be got rid of without raising a stock again from a single grain, and when necessary doing so again and again.

In the fourth reproduction of King Richard, an ear was selected from the crop with red chaff, and from its seeds was raised a new variety called King Red Chaff White. My whole stock of this wheat, about a bushel and a half, was presented to the late Mr Alexander Begbie, Barneyhill, near Dunbar.* The grain of this

* Mr Alexander Begbie was one of my earliest friends who encouraged me in growing improved cereals, and but for whose

variety, the growth of Barneyhill, was seen for the first time in bulk in Edinburgh Corn Exchange in the autumn of 1870, and also in 1871; and it was generally admitted in both years to be the finest sample that had appeared in these years. The straw is large in circumference, very strong, and some inches shorter than King Richard, while the ear is closer set without approaching club-shaped, with red beardless chaff. The grain is white and large, and, like King Richard, is a type of Talavera. As far as my observation goes, this variety is early, constant on reproduction, and tillers most freely. Altogether, I am at present disposed to regard King Red Chaff White as perhaps one of the best wheats I have raised.

Having crossed King Richard with King Red Chaff White, several fine varieties with red chaff and large white seeds were obtained, two of which proved constant, and three inconstant. One of them, after the third reproduction, was presented to Mr William Stephenson, Hathery-

disinterested kindness the wheats King Richard and King Red Chaff White might never have been known to the public.

hall, near Haddington, and to whom my thanks are due for accommodation of land on several occasions for my trial-plots.

On Talavera, which has white chaff, having been fecundated with pollen from a small white-seeded variety with red chaff, the plant from the seed, in form of ear and seed, closely resembled Talavera, but the colour of the chaff was red. In the crop of the second reproduction, the form of the ear was unchanged, but about two per cent of the ears had white chaff, the seeds of both kinds of chaff being identical with true Talavera, as well as in foliage and length of straw. For years the seeds of the different-coloured chaffs have been separated and sown in my trial-plots, and in 1871 a few white-chaffed ears appeared in the crop of the red-chaffed seeds, but the crop of the white ears was unmixed.

A downy-chaffed variety with tall straw, which had been selected from Hopetoun, was fecundated with pollen from Talavera, and the result was a constant variety with the downy

chaff and fine straw of the seed parent, the grain being nearly as large as Talavera.

A plant from a seed of Shirreff's Bearded White, which had been obtained by fecundating a floret with pollen from an ear of the same plant, was a second time fecundated in like manner in the following year. Of three seeds so obtained, one grain gave rise to a plant with bearded white chaff similar to the parents, a second had beardless white chaff, and the third white semi-downy chaff. The colour, form, and size of the seeds were as dissimilar as the chaffs, and the seeds of none of the ears proved constant on reproduction.

When I commenced the improvement of the cereals, doubts were entertained about one variety of wheat fecundating another when growing in close proximity by natural agency; but my trial-plot of 1859 afforded evidence which in my mind set this matter at rest. The mixtures of red and white chaffed ears, noticed at p. 10, might have been accounted for in different ways. But one of the fourteen varieties which formed my collection of that year was

remarkable in appearance, the chaff being without awns, densely downy, and of a smoky colour, difficult to describe, and constant on reproduction. Some years before, this variety had been selected from a crop of the woolly ear, common to the country, and entered in my list as dun wheat—a name which occurs in an old agricultural work, and in the present instance may perhaps be misapplied. In 1858, this variety and Shirreff's Bearded White had been grown contiguous in my trial-plot; and there was selected from the bearded wheat in 1859, an ear with chaff like dun wheat, and with the beard and the form of the ear of Shirreff's Bearded White. The plants from the seeds of this natural cross-bred ear were all destroyed, except thirteen, by wire-worm and other insects; and such was the sporting nature of this wheat, that fifteen or sixteen ears, all different in form or chaffs, were gathered from the third reproductive crop in my experimental plot, and they were placed in a cabinet which is still in my possession. Notwithstanding such diversity of chaff, there was uniformity of leaf and grain.

It is not the practice in East Lothian to mix varieties of a cereal, for sowing and genuine samples of seed command a preference. I was led to examine some of the growing farm-crops in East Lothian as to genuineness. Hunter's wheat, which for long was the leading variety in East Lothian, was found to abound in many kinds, and nearly forty per cent of the whole crop consisted of semi-woolly white-chaffed ears. Such ears can be best seen when the crop is in bloom, and when the sun is shining low in the horizon. The chaff of wheat appears to be as variable as the petal leaves of many flowers, without always involving a change in the form and colour of the seeds. Hopetoun wheat was also found to contain many ears with semi-downy chaff, which appears to be a form of sporting common to many varieties of wheat.

Having satisfied myself of the possibility of changing the seeds and external characteristics of the wheat plant by crossing, I resolved to attempt altering the habit of ripening. In entering upon such an undertaking, I would have liked to have begun the attempt with the

best summer wheat, which, according to Linnæus, is a different species from the winter wheat grown in Britain. There being only two kinds of summer wheat in my collection, I fixed upon a variety which is said to be the red wheat of Tuscany in Europe, and is known at Mark Lane by that name; and it was presented to me by Mr James Melvin, who brought it from New Zealand. The grain when grown here is high-coloured, and of medium quality and size—the straw being very short and slender, supporting a well-formed ear with creamy chaff without awn or down. In bright warm summers the chaff assumes a darker shade; and the straw, which is usually white, becomes pinkish, and more especially so above the upper joint. The colouring of the straw is partly owing to the sun's rays, and is exemplified in all our cereals by the surface exposed to the mid-day sun being most affected. In Scotland, the straw of ripe cereals is usually a dull white, and the golden hue of harvest so gladdening to the eye of the farmer is indicative of good quality of grain and of good crops. Having grown Tuscany wheat for four or five

consecutive years, it was found to come into ear, and also to ripen, eight or ten days earlier than other kinds; while the produce in quantity and quality was satisfactory. When sown in the middle of November, and later in the season, the climate of East Lothian did not injuriously affect the crops. The variety, however, proved to be a true summer wheat, coming into ear and ripening as soon as the earliest barley of Scotland sown under a parity of circumstances. Winter wheat, when sown in East Lothian in the middle of April, or later in the season, does not usually come into ear until the following season. On one occasion, by way of experiment in this locality, I sowed both kinds of wheat on March 15th, April 15th, and May 15th. The March seeding eared in the usual way with both wheats. In the case of seeding in April, the summer wheat soon eared; while only two abortive ears and stalks came forth from the winter wheat, the rest of the plants being leaves. With the May seeding the summer wheat eared and ripened, but the winter wheat continued tufts of grass throughout the season. On the 18th July

1870, I sowed an early variety of barley contiguous to red Tuscany wheat. Both of the cereals blossomed before being cut down by frost ; and throughout their growth the wheat appeared to be more robust and earlier than the barley. The non-earing of winter wheat when sown late in spring, is a property inherent in the species, and of which wheat-growers ought to be aware.

In 1869, I, unassisted, crossed Tuscany with King Richard, and also with Talavera, the chaff of all the breeders being free of down and awn. These crossings were undertaken with the object of improving the straw and the grain of Tuscany, as well as to impart early ripening to King Richard, or to some of the descendants of this cross.

The ear of Tuscany which I crossed with King Richard yielded eleven seeds, which were planted in thumb-pots ; but only seven plants were carried to the field, where one of them soon died, leaving six plants from this cross. The cross with Tuscany and Talavera produced one plant, making in all seven crosses from Tuscany. In 1870, the plants from the whole of the surviving arti-

ficially-fecundated seeds throve well, and two rows of each of them were included in my comparative trial-plot for crop 1871. Occupying no land myself, I was indebted to others for space to grow my wheats upon year after year. In the present case I was unfortunate in soil, which was too rich manurially, more especially where the Tuscany cross-breds were sown, which had lately been the site of a dung-heap. But being still more unfortunate with my crops in 1872, a few excerpts from my note-book for crop 1871 relating to these cross-breds will be given, being their second reproduction.

No. 1. Came into ear on the 16th June. The length of straw was 3 feet 2 inches. Chaff cream-coloured. Ears partly white and partly creamy, and some of both kinds with wool and without wool. Grain high-coloured, coarse, and large.

No. 2. Eared on 12th June. The length of straw 3 feet 5 inches. Ear handsome. Chaff white. Straw white. Grain white, longish-shaped, and fine in quality.

No. 3. Showed the ear on the 9th June, with

length of straw 3 feet 9 inches. Chaff light red. Straw pinkish. Grain a shade lighter than the grain of Tuscany, and larger—a good sample.

No. 4. Eared on the 14th June, with length of straw 3 feet 3 inches. Chaff red, with a few white-chaffed ears. Straw pink. Grain high-coloured, round, and coarse.

No. 5. Eared on the 10th June. Straw 4 feet 6 inches in length. Ear thin-set, red, chaffed with a few white-chaffed ears. Grain high-coloured, long, coarse, and large.

No. 6. Eared on the 8th June. Length of straw 3 feet 10 inches. Chaff red, and no mixture of ears. Grain resembling true Tuscany. Nos. 1, 2, 3, 4, 5, and 6 slightly blighted in ear, which may have arisen from attacks of the wheat-fly, combined with the richness of the soil.

No. 7. A cross with Tuscany and Talavera. Eared on the 10th of June. Length of straw 3 feet 3 inches. Chaff and straw white. Grain white and large, seemingly a type of Talavera.

In 1871, some of the plants from seeds which resulted from cross-fecundation appeared to show

a strain of summer wheat by being first in ear ; and to at once determine this point, I sowed in a garden on the 13th September of the same year rows 4 feet in length of the following wheats: Hunter's, Fenton, Tuscany, Seedlings No. 3, No. 2, and No. 7. The winter which followed was upon the whole mild, although the thermometer upon several occasions indicated 10 degrees of frost, which killed some plants, perhaps two-thirds of the whole of Tuscany and No. 3 Seedling. The Seedlings No. 2 and No. 7 appeared the tallest and the most vigorous throughout their period of growth ; but they came into ear at the same time with Hunter's and Fenton, and eight days behind Tuscany and No. 3 Seedling. Thus, from seven seeds of fecundating summer with winter wheat, resulted five varieties of summer and two of winter wheat.

In 1871, several of the crosses from Tuscany, by coming early into ear, indicated a strain of summer wheat, and they were at once made subjects of crossing without waiting for another year to ascertain the nature of their seeds. Fortunately, at that time several young friends

wished to learn the hybridising of wheat, and the cross-bred plants alluded to were set aside for them to practise with, crossing under my superintendence.

The attempted crossings of my young friends and myself furnished many seeds ; and my experimental plot of 1871 contained upwards of eighty kinds from this source. The succeeding crops were not considered satisfactory, from over-luxuriance ; and after setting aside nearly one-half of them with the least promising grain, upwards of forty of the remainder were sown in my experimental plot of 1872. From the state of the ground and the nature of the season, both unprecedentedly adverse to wheat from sowing to reaping time, aided by insect and vegetable pests, the whole crop was wrecked, and scarcely enough of seed saved as perpetuate the kinds. Another attempt has been made for crop 1873 ; but in the mean time no conclusion can with propriety be drawn.

My experimental plot in 1871 contained upwards of forty plants. It would be premature to say much about my second group of hybrids,

but several of them came into ear as soon as their common parent, Tuscany, with longer straw and grain of considerable promise.

In the third year of reproducing Tuscany in my trial-plot, either a sport or a natural cross made its appearance, having a thin-set, white-chaffed ear, with long white grain of good quality. The straw is of considerable length, and the habit of the plant early and constant. This variety had been used in crossing in 1871.

Sports are understood to be plants which differ from the common type; they often appear in cultivated crops, and also, but much less frequently, amongst plants in a state of nature. The proneness of plants to sport generally increases with the reproductions which they undergo when under the care of man. Acts of husbandry cannot be said to directly give rise to sports, but the higher the state of cultivation in which plants are kept they are the more likely to sport. The nature of the inflorescence of plants also affects their sporting—those with exposed organs of fructification being more liable to sport than those with concealed organs.

Insects and air are acknowledged to be agents in sporting, both occasionally being a medium of conveying pollen from one plant to the female organs of another of the same species, and by this means producing similar effects to the hybridisations of man ; and the classification may be adopted of natural and artificial sports.

In the case of wheat, any plant which appears with foliage, straw, ear, chaff, or grain different from the type which has been used as seed, may be considered a sport ; and if constant on reproduction, as also a new variety. Considering how long and how extensively wheat has been cultivated, exposed to influences favourable to sporting, the crops of the present day are frequently less mixed than could reasonably be expected. But amongst every kind sports now and then appear, and perhaps from this source have sprung many of the varieties which have been found adapted to so many situations and climates over the world. My selections have chiefly been from natural sports, which soon show their properties, and often prove constant, having in all probability undergone reproduc-

tions before being selected. The finest sport is most likely to arise from the best kind, one good variety generally being the forerunner of a better one ; and sports may be regarded as the gifts of nature to man. The case of sporting which occurred amongst my experimental plot of wheats in 1860, and which has been noticed at p. 10, is in my experience anomalous. When the ejection of the anthers from the capsules takes place, much of their pollen is sometimes scattered about, and may possibly have been carried by wind or other means to the stigma of surrounding florets, producing variation in the succeeding races.

With the view of investigating some of the causes of sporting, in the following season I planted seeds of varieties with distinct characteristics together in the earth, the plants growing and the ears mixing together when blossoming. The ears of the different kinds, when ripe, were separated, and their seeds sown for another crop, which did not contain a single sport. If varieties growing contiguous are always instrumental in fecundating each other, my experi-

mental plot must have long since become a heterogeneous mass, when between one and two hundred sorts have been grown within a foot of each other for nearly fourteen years. On the contrary, my crops were less mixed than those of the surrounding district, and a sport has never been seen amongst the great majority of them. The seeds used for reproduction in my experimental plot were always selected by myself over a table, and never underwent a change, either of soil or climate. There is a variation which may be called spontaneous sporting, and is chiefly noticed in ears with different chaffs branching from the same parent root—having noticed in this position chaffs without down and with it, and also with and without awns.

Foreign countries have seldom been known to furnish a good new variety of wheat suited to the climate of Britain. At one time envoys of this country were requested to transmit wheats from the countries where they resided ; and through the kindness of the late John C. Loudon of Bayswater, a few seeds of many of them came into my possession. The seeds generally ger-

minated well, and the plants withstood the rigours of winter ; but in the course of summer, the blossom, the chaff, the grain, and the straw generally became so diseased, that none of them were considered worthy of cultivation in East Lothian ; but it is probable that my inexperience at the time may have contributed in some degree to the failure. Many of these wheats had come from warm climates ; but I have since grown seeds from temperate regions, including California, New Zealand, and parts of Australia. Most of the kinds from the colonies, on reproduction in my experimental plot, appeared to be identical with varieties in the mother country, and unchanged by soil and climate.

A collection from the districts around Bombay, when grown in my trial-plot, became affected by the climate in the end of May ; but my attempts to cross them with home varieties proved unsuccessful, the pollen of the foreign wheats being apparently deficient in quantity, and perhaps also in quality. But many varieties from foreign countries may be found useful in crossing with British.

The increasing of wheat from a single grain or a greater number, can be soonest accomplished by thin seeding, although the system of transplanting has been recommended for this purpose. Choose a soil of considerable stamina, manurially rich, with free access to air and sunshine, and allow a space from nine to twelve inches square to each seed. Prefer part of a field which is to be cropped with wheat, leaving a vacant space of a yard wide between the ordinary wheat and the select variety, taking care that the ears of the two kinds do not intermingle during their growth. If thought proper, the second reproduction may be carried out in a similar manner, but the seeds may not be placed so wide apart. Seldom will the third reproduction of a single grain be sufficient for field-practice on a considerable scale; but the produce of the fourth reproduction may vary from twenty-five to eighty quarters, according to the cultivation which has been adopted and the nature of the seasons during the propagation.

The system of transplanting wheat was perhaps first tried by Mr C. Miller, Cambridge, in

1765. An account of his experiment appeared in the London Philosophical Transactions, vol. lviii. p. 203; and it was afterwards copied by Sir H. Davy and others, and it is included in a treatise on wheat by the "Old Norfolk Farmer," published in 1865. Mr Miller planted on June 2d a grain of wheat, the plant being taken up on August 8th and divided into eighteen parts, which were planted singly. In September and October the plants were again taken up and divided, producing sixty-seven plants. Between the middle of March and April 12th of the succeeding year, a third and final division and planting took place, producing five hundred plants. The result is thus stated in the original document: "The whole number of ears which, by the process before mentioned, were produced from one grain of wheat, was 21,109 ears, which yielded three pecks and three quarters of clear grain, the weight of which was 47 lb. 7 oz.; and from a calculation made by counting the number of grains in one ounce, the whole number of grains might be about 576,840."

Mr Miller's system of transplanting greatly retards the increase of wheat compared with thin seeding. The single grain which was selected for the experiment must have been matured in the previous autumn and placed in the soil in June following; thus a summer passes away in preparing plants which require another summer to ripen them. The case of thin seeding may be illustrated practically by a plant from one grain of Mungoswells wheat noticed at page 1, which produced 2473 grains in the first year. If these grains had been planted in the autumn following, and produced in the same ratio as in the first year, the produce of the second harvest would have been 6,115,729 grains. This plant from a grain of Mungoswells wheat was not so remarkable as one raised by my brother, C. H. Shirreff. In the spring of 1870, he observed growing amongst others in his garden at Edinburgh a fine wheat plant, which was carefully preserved. On reaching maturity the plant was found to consist of eighty stalks, the ears of which yielded 4524 grains, weighing 7 oz. The stool of this plant is in

my possession. For the second crop, the wheat was planted in October of the same year on the seventeenth part of an acre of a market-garden at Dunbar. A portion of the crop lost plant considerably during winter, owing perhaps to the depredations of the small birds frequenting the fruit-trees and bushes, with which the garden was studded. On the wheat coming into ear, the space was covered over with a net; and had this been done at the time of sowing, perhaps no loss of plant would have happened. From the attacks of birds, insects, and other causes, not more than 2395 plants were found to have survived the winter. During the ripening and harvesting many seeds were lost, but what were saved of the second year's crop weighed 10 stone 12 lb. The produce of the second year was placed under the care of David Drysdale, Esq. of Congalton, who planted the seeds by the common drill on the farm of Pleasants, near Dunbar, on the 9th March 1872, the ground receiving no treatment beyond the most ordinary farm-management without top-dressing. The extent seeded was 2 acres, 23 poles, 24 yards,

imperial measure ; the yield, 48 bushels of marketable produce—being the increase of a single grain in three years. The wheat harvest of 1872 was a most deficient one in East Lothian ; and but for this circumstance, joined to the loss of plant in the market-garden, the increase would have been considerably greater. The variety cannot with certainty yet be determined, but it is thought to be one of the wheats common to the country. I had frequent opportunity of seeing the crops when growing, and rely on the details given to me. The system of transplanting wheat, as followed by Miller, is fallacious, as requiring two years to produce one crop ; and this disadvantage cannot be got rid of, however long the system may be carried out ; and it is somewhat remarkable that such a system should have found favour with some writers up to a recent date.

In addition to what has been said at page 18 about the ear of wheat, it may be here mentioned that this part of the plant varies in different varieties, and also in the same variety according to the circumstances in which the

plant has been grown. The most attractive feature of the ear is length, which, however, is sometimes fallacious ; the true measure of worth being the number and size of the seeds which the ear contains. A general effect of luxuriance of growth upon the ear is to lengthen the spaces between the notches without always increasing their number. A wheat ear, of British farming, is commonly composed of from thirteen to seventeen fertile notches, having from six to eight on each side, with one forming the apex ; the greatest number which I have seen on one ear being twenty-seven. But notches support spikelets of various forms and degrees of fruitfulness. In ordinary crops of the farm the spikelets have from two to five seeds arranged in the usual form, which resembles a lady's expanded fan ; but instances occur of spikelets on the common wheat of Britain having from six to ten seeds. In spikelets with seven seeds, four of them have often the common arrangement of the fan, with three others projecting from the base, and sometimes pointing upwards and sometimes downwards. I have in my possession

an ear of crop 1871 with nine seeds on a spikelet, and have formerly had spikelets with ten seeds. In such cases the ear did not resemble the ear of Egyptian wheat, *Triticum compositum*, but the seeds seemed to have been pressed out of their natural positions on the notch, and had acquired something like the arrangement of double teeth in the human mouth, and gave a sort of circular form to the cluster of seeds. The ear of wheat is greatly affected by the state of the crop when growing. When the plants stand too thick on the ground, the spikelets seldom contain more than two seeds, and at the lower part of the ear often six or eight notches are found to be barren or void of chaff. The effect of a thin plant is an increase of the seeds on the spikelets, and to render all the notches fertile. As an illustration of the effects of a thick and a thin planted crop on the ears of wheat, I selected six average-sized ears from a thickly-planted part of a field, and also six average-sized ears from a more thinly-planted part of the same field. The following results were obtained :—

Six average-sized ears from thickly-planted wheat
measured 16 inches.

Fertile notches numbered	.	.	.	71
Infertile notches	„	.	.	31
Total seeds	„	.	.	148

Six average-sized ears from the thinly-planted wheat
measured 25 inches.

Fertile notches numbered	.	.	.	117
Infertile notches	„	.	.	5
Total seeds	„	.	.	326

The quality of a wheat crop is often affected by the way the plant stands upon the surface. When the crop is too thick the grain is small, plump, and fine ; when the crop is too thin the seeds are large, rough, and coarse. In my experimental plot I have found each of the outside rows and two or three plants at the ends of each row throughout the plot have tall straw and coarse seeds, as well as being later in ripening.

I have been presented at different times with two distinct ears of wheat upon one stalk, and several such ears have been picked up by myself. At present there is in my possession ears of this description (crop 1871), one of them containing forty-five seeds, and the other twin-ear thirty-six.

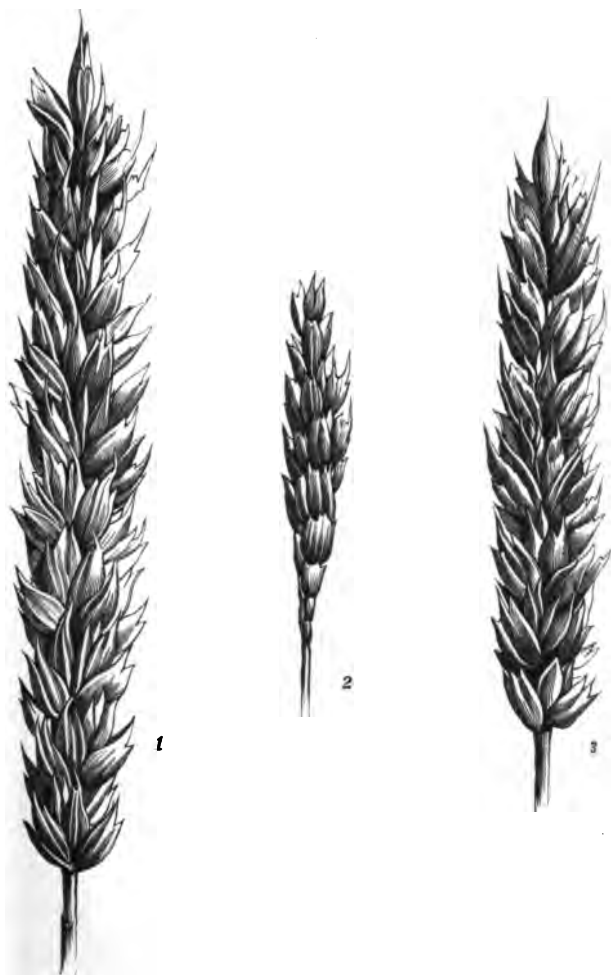


PLATE III.—1, Ear of thinly-planted crop ; 2, Ear of thickly-planted crop ; 3, Ear of medium-planted crop.

Both of the ears are perfect in form and distinct from each other, and connected with the top of the stalk common to both. But double-eared stalks and any considerable irregularity of spikelet and ear I have failed to reproduce from seeds, and regard such as monstrosities.

The ear varies with the chaff, which is much diversified in colour and form. I have grown varieties with mottled chaff with long awns, having the under half of a dark shade and the upper half light-coloured. The outer valve of the capsule is strong in the middle longitudinally, and curves toward the edges into thin curtains, which are semi-transparent when the ear is first visible. About this stage of the plant's growth the thin curtains of both valves overlap, and the embryo blossom is protected by them from all external influences. As the plant advances, the curtains partially withdraw, and perhaps the hair-like ovipositor of the wheat-fly first obtains access to the blossom within the capsule. The chaff forms the cradle of the blossom and the clothing of the seed. The white, the red, the thick, the thin, the rough, the smooth, the bearded, and the beard-

less chaffs may all be fancied ; but, like the garments of the human race, they form no guide to the colour or the worth of the object underneath the covering.

The awn or beard which characterises some varieties both of winter and summer wheat, is always attached to the chaff-scale, which covers the convex side of the seed, and is of use in some circumstances. In windy weather a long stout beard tends to lessen the shock of the ears beating about ; and by keeping the ears apart in the sheaf, sunshine and air are more freely admitted, and consequently the grain gets sooner into condition than varieties without beards, and is also more tardy in sprouting in wet harvests.

Farmers very generally express partiality for a thick-set ear to one that is thin set—that is to say, they prefer the notches to be near instead of wide apart. But there are good grounds for questioning the soundness of this conclusion. Wind and rain are considerable hindrances to the cultivation of wheat throughout Britain. During high wind the thick-set club-shaped ear strikes with greater force than the long thin-set ear, and

consequently sheds more of the seeds. In wet harvests the ears in a sheaf of close-set wheat are less accessible to air and sunshine than in a sheaf of wide-set ears, and consequently more liable to sprout ; even with uncut crops the club-shaped ear is longer in drying. But the distance of the notches from each other is perhaps a fancy in which farmers may indulge without greatly affecting their pockets, except in very wet harvests.

Next to the ear, the straw is perhaps the most important part of the plant. The stalks or straws spring from a common root, and are made up of four tubes divided from each other, and knit together by nodes, joints, or knots, which are solid, and which increase their strength and elasticity. The stalks of varieties differ in length and circumference ; for four or five inches below the ear the stalk of some kinds is solid or filled with pith, and from the root to the first joint is the shortest tube and the strongest portion of the straw. The chief property of straw is resistance to bad weather by continuing erect until the crop is ripe. Some kinds of wheat are more easily

lodged than others, but with all varieties the power of resisting bad weather depends on various contingencies—such as the thickness and the thinness of the plant on the ground, the texture and manurial condition of the soil, and the nature of the weather throughout the growth of the crop. But experience does not point out that short-strawed wheats are less injured than long-strawed ones in adverse seasons. On the contrary, the Rivet, Spalding, Kessingland, and Browick varieties are said by farmers to be remarkable for withstanding bad seasons, and are the longest-strawed wheats in cultivation. There is a principle of life peculiar to every species of plant, and the stalks of wheat display vital energy in different stages of growth. When early trodden down they soon rise again, and when they become prostrate from over-luxuriance, the ear and the straw from the fourth joint often point upwards. During wind the elastic stalks bend and wave to and fro in all directions; and when weighed down by rain, vital energy usually raises them up when dry. In practice it has been found that when wheat crops have been grown under circumstances favour-

able to healthy development, the straw of almost every variety possesses sufficient vital energy to continue erect until ripe. A stalk of wheat ought to yield to pressure, and, like a fishing-rod, return to its original position on the cause of disturbance being removed. A description of the wheat crop of 1856, taken from my note-book of that year, may tend to illustrate the properties of straw: "The weather in East Lothian during the present season has been singularly favourable for testing some properties of the wheat plant. During the months of April and May the crop appeared to be early and luxuriant; but June and July proving cold and wet, the luxuriance was repeatedly checked. The advance of the season brought little change in the weather, until October, which continued mild, calm, and damp till the close of the month. Ultimately, the crop was found to be late in ripening, long in the straw, not much lodged, poor in quality, and sprouted to an unprecedented extent. Autumn and spring sown crops partook of the same character, and afforded a rare instance of a bulky crop standing erect in a wet and boisterous

season. Long-strawed white varieties, measuring nearly six feet, were to be seen unlodged. Some tall crops of white varieties were repeatedly lodged by storms from different points of the compass, but time after time they rose again. The straw of every variety, although stiff as wire, must occasionally yield to the joint pressure of wind and rain ; and a crop lodged by such agency cannot regain an upright position unaided by vital energy, which may be read in the sense as stiff straw."

One of the chief difficulties which an individual experiences when improving the wheat plant is to ascertain the quality of the grain, or the flour produced from it. With all varieties where there is diversity of soil, the quality of the seeds from one portion of a field varies from those grown upon another, and even seeds from the same ear differ widely. In an inquiry of this nature the aid of the chemist is thought to be of little avail ; and that the baker's bread, taking colour, quality, and quantity into consideration, is a more satisfactory test to the farmer. Wheaten bread—the staff of life—as used in Britain, re-

quires perhaps more diversity and nicety of preparation than many other articles of vegetable food used by man. First comes the farmer's influences upon the grain, then the miller's upon the flour, and, lastly, the baker's upon the finished loaf. Very differently situated are the improvers of many other edible products. New fruits can generally be judged by the palate without any preparation; and Mr Knight's hybridised peas could be tested after undergoing the simple process of boiling, and new flowers by the faculty of sight. But such are the difficulties of comparing a new with an old variety of wheat—from the sowing of the seed to the loaf upon the table—that few individuals are competent to undertake the task. I have often experienced difficulty in determining the fitness of new varieties for propagation, and guided my choice chiefly by the appearance of the grain likely to fetch most money in the market, other properties of the plant being taken into consideration. This measure of the worth of new wheats is not entirely satisfactory, and I may probably have rejected from my collection

varieties of merit. It is commonly understood to be one of the objects of agricultural associations to give premiums for improvements which individuals seldom attempt when left to themselves, and my attention was early directed in this direction of proffered reward.

In recording some of my experiences in improving the cereals in connection with public associations, I shall endeavour neither to exaggerate nor lessen the difficulties which were thrown in my way, believing a truthful account of them may be of use to individuals who may pursue the same object. The following quotations are taken from documents printed and circulated at the time when the proceedings occurred.

About the year 1822, I was induced to become a member of the United East Lothian Agricultural Society, then in the third year of its existence. East Lothian, from the favourable nature of its climate, has long been celebrated as a corn-growing district, and the Society at once set about encouraging the staple products by holding shows of seed-corn, and awarding premiums to the best parcels

exhibited in bulk—a system which is still continued. Not long after, being a member, I proposed, and the Society sanctioned, a premium for the introduction of new plants adapted to the agriculture of the district.

With further experience, I stated at a general meeting of the Society that the plan followed in giving premiums for the best parcels of seed grain pitched in the market-place in quantities of 10 quarters had no tendency to improve the cereals—the means taken to secure success at a seed exhibition being excessive dressing, so as to remove the seeds of weeds ; and however well this object might be accomplished, the grain did not become more genuine nor changed in any way, while the germinating properties of the seeds were often impaired, if not destroyed. Seeds are the most minute, valuable, and mysterious parts of the cereals. Each seed contains within itself a germ of life, which the elements of nature vivifies and raises into a plant, the characteristics of which cannot be known before it reaches maturity. A genuine wheat crop cannot be accurately judged

by a measure of grain, any more than pure-bred adult fowls from a basket of eggs.

I recommended the Society, without doing away with its present premiums, to try the effect of a new scheme consisting of three parts, as follows :—

First, To ascertain by actual experiment the varieties best suited to the district.

Second, To give premiums for the most genuine crops, and these to be inspected when growing and near maturity, their characteristics being then fully displayed.

And third, To give premiums for new varieties.

The scheme was favourably received by the members, and in due time a premium was announced for an experiment with three varieties of wheat compared with Hunter's, then considered the standard variety of the county. Judges were to examine the crops and to report to the Society, and the experimenters were also required to report.

On the first part of the scheme the judges reported favourably, and recommended that the experimenters, Mr George Hope and myself,

should receive each a premium; which was accordingly done. As a beginning of the scheme, the experiments proved a success, and the Society homologated the principle of comparative trials by again offering the like premiums, and also by offering premiums for experiments with three varieties of Swedish turnip.

The second part of my scheme for improving the cereals appeared in the premium list of the Society as follows :—

“A premium of five sovereigns will be given for the most genuine crop of Hunter’s wheat of not less than twelve imperial acres crop 1835. Competitors to intimate intention to compete by 1st January 1835, and lodge with the Society a statement of *how* and *where* they obtained the seed, and the means taken to render it genuine. The wheat to be inspected shortly before ripening by a committee, who will report on the crops as to the mixtures of varieties they contain, and preserve specimens of the ears for the use of the Society.

“A premium of the like amount and on the same conditions for Mungoswells wheat.

“A premium for the like amount and on the same conditions for Blood-red wheat.”

For this class of premiums three members intimated their intention to compete on the Society's conditions.

1st, Mr Robert Hope, Fenton Barns, competed with Hunter's wheat and Blood-red, a provincial name for Dunstable. He stated his mode of keeping his crops genuine as follows: “The plan pursued for this purpose has been by repeatedly growing my whole crop from the produce of a handful or two of the finest heads I could select, occasionally employing people to pick out the ears of other varieties, when such were observed, both in the field and in the barn, as found most convenient.” 2d, Mr Francis Shirriff, Muirton, also competed with Hunter's wheat and Blood-red, the former having been hand-picked before being thrashed by Mr Hunter of Tynefield, the grower of the wheat. 3d, I myself was also a competitor with Mungoswells wheat, and stated in my intimation to compete, —“This variety was discovered here (Mungoswells) in 1819, and propagated from one plant,

and I have raised it a second time from a single grain."

A committee of three members was appointed to examine the growing crops, and to report on them to the Society. Long after the time such documents were usually made public, a report purporting to be from the committee was read at a general meeting of the Society by the secretary, in a hurried, indistinct manner, partly put on for the occasion, so that few members could catch its import, beyond that no premium could be given. Contrary to former practice, the report was not published with the proceedings of the Society, and I was denied a reading of it, as well as of the minute-book of the Society.

While in suspense regarding the reasons assigned in the report for withholding the premiums from the genuine wheat crops, it was consoling to myself to know that the second part of my scheme had the approbation of such experienced and practical farmers as Mr F. Shirriff and Mr R. Hope, and that their method of keeping crops genuine, as stated in their intimation to compete, was obviously in-

ferior to my own practice. The non-printing of the report, and denying me access to it, raised suspicions that there had been some questionable actings in the matter, which were afterwards realised. But in the mean time, being impressed with the justness of my views and the importance of improving the cereals, I resolved to bring before the Society the whole scheme, trusting that it would be acted upon at a future period, although perhaps a distant one. The premiums for genuine crops were withdrawn from the Society's list.

In April 1836, I brought forward, at a meeting of the Society intimated at the previous December meeting, a motion "That the field of Mungoswells wheat exhibited, and inspected by the committee in 1835, is entitled to the Society's premium of that year;" and on the motion being seconded, an amendment was moved by Mr George Hope, "That the report of the judges be approved of, and that the thanks of the meeting be given to them for their trouble in the matter,"—which was carried.

After an interval of many years, the report

of the committee on the second part of my scheme came under my notice, and was found to be as follows :—

“We regret having found it necessary to give in the following report on the crops we were appointed to inspect of Hunter’s Blood-red and Mungoswells wheat exhibited for the premiums given by the Society. We considered that these premiums originated in an anxious wish on the part of the Society to have it in their power to obtain more genuine seed of each of these varieties of wheat than the premiums usually offered in September and October had had the effect of producing; and this particular mode of inspection was fixed upon in order that they might pass through a more severe ordeal than it was possible for them to do after being thrashed out and pitched in a sample-bag. If we have therefore formed a correct estimate of the intention of the premiums, we think ourselves justified in giving our opinion that none of the crops were of sufficient merit to obtain them.”

1st, Hunter’s wheat.—“We inspected two

fields of this variety, both of which were free from smut, puple, &c. ; but we found in both a considerable number of woolly ears and some heads of red wheat. We do not think it will be possible to detect anything wrong in the sample-bag ; but neither of them, in our estimation, was sufficiently pure to merit the premium."

2d, Blood-red wheat.—"We also inspected two fields of this variety. In one of them we found a good deal of grub grass. They were both free from smut and puple ; but they were considerably mixed with white wheat, and were certainly less genuine than Hunter's wheat."

3d, Mungoswells wheat.—"There was only one field of this variety exhibited, and though it could not be said to be perfectly pure, was much more so than any of the other fields we went through. We would have had no hesitation in awarding the premium in this case had we not detected several heads of smut, though not enough to affect the sample, yet too much to pass over in an inspection of this kind.

"We should be sorry if we have been too severe, but we did not consider we had it in our

power to act otherwise, considering the nature of the premium."

I have recently learned from two individuals whose names are attached to the report, the third individual being dead, that they had no hand in preparing the report, which had been rendered colourable by its author assuming conditions for himself, and setting aside those in the Society's printed premium list. When Mr George Hope moved "The adoption of the report and thanks to the committee for their care and trouble in the matter," he could not fail to have known, from the position he occupied in the Society, the author and the handwriting of the document alluded to. The success of this stratagem in all probability afterwards led to its repetition in the case of the Highland Society, which will be noticed in the sequel.

Soon after joining the Society, it became well known that my opinions were unfriendly to the national corn-laws, and other antiquated practices hurtful to agricultural progress. In such a state of matters I encountered much opposition to many of my proposed measures. One of the

secretaries attached his signature, and the other was chiefly instrumental in circulating, along with the printed proceedings of the Society, libels upon my character ; and such was the unfriendly feeling raised, that my expulsion from the Society was arranged to be attempted at the next general meeting. But on the day of trial the contemplated expulsion not only proved a failure, but some of its most prominent supporters were humiliated for their folly. The salaried secretary, Mr Alexander Donaldson, who had long swayed the councils of the Society, in order to avoid an action for defamation—for language which he used at the meeting in question—gave me, in writing, an apology, with the option of publishing it, of which I did not avail myself. The curb of such a document upon him proved so galling that he soon afterwards resigned the secretaryship.

Thinking it improper for Mr Robert Hope's libels on my character to continue on the records of the Society, I wished to effect their erasure ; and after some opposition, at last—as a compromise—I was allowed to place on the

minutes, and to circulate, with the Society's printed proceedings, the following disclamation: "Mr Hope having declined defending his statement when repeatedly brought under the Society's notice, an opportunity of fully vindicating my character did not occur. I now therefore declare the statement substantially unfounded, and my readiness to refute each and all of its allegations when regularly brought before the Society."

I had also, previous to the period alluded to, made application for the Society's premium for new plants with the Hopetoun oat. The application was opposed by the managers with every kind of low intrigue, and years passed away before the members at a general meeting took the matter out of the hands of the standing committee and made a favourable response to my application.

Thinking that all ill feeling towards myself as a member of the Society had passed away, I wrote to the secretary, Mr Walter Howden, in April 1841, to give the usual notice of my intention to move, at the next meeting, a motion for pre-

miums to seedling wheats, which was the third and last part of my scheme for improving the cereals. The following extracts from the printed proceedings of the Society will show the result of my motion :—

“Mr P. Shirreff brought forward his motion on the subject of seedling wheats, and in doing so, first moved that a premium for seedling wheats be given, which motion was seconded and carried. Mr Shirreff then moved that in place of the premiums of which notice had been given three premiums be given; the first of £20, the second of £15, and the third of £10. The competition to take place in 1846; and in the event of one or more of the seedling wheats surpassing Hunter's variety, a farther premium of £105 be given to the best seedling, and fifty guineas to the second best. Intimation of intention to compete must be given to the secretary in writing previous to the 1st January 1846, and a statement lodged describing the characteristics of the variety and the circumstances attending its selection and propagation. A committee to be appointed to report on the appearances of the crops when growing, and of the grain when

matured, and if the wheats are new in the cultivation of the country. A quantity of not less than two bushels of grain of crop 1846 of each kind of wheat obtaining the premiums, or of all varieties commended by the committee, to be placed at the disposal of the Society by the 26th October of that year, for instituting, under the direction of the committee, a comparative trial into the produce of the wheats and quality of their flour: which motion was seconded. Mr George Hope moved as an amendment that a note shall be added to the "extra premium," No. 7, "that in the event of any person claiming this premium, the committee shall have it in their power to demand five bolls of the new variety of wheat upon paying £15, 15s., in place of paying £5, 5s. without the wheat, to give it farther trial; when, if a majority of those conducting the experiment along with the committee report in favour of its superiority to Hunter's, a farther premium of £50 shall be awarded to its propagator, which amendment was seconded.

After some discussion the motion and amendment were both withdrawn, leaving the details to

be specified by a committee consisting of five members, who were named. The premiums in the Society's printed list stood thus:—

“SPECIAL PREMIUM FOR SEEDLING WHEAT. 1st, £100 is offered for the best seedling wheat. 2d, The competition to take place in October 1846. Notice of intention to compete, with a description and history of the variety, to be lodged with the secretary by the 1st January preceding. 3d, No premium will be given until the Society at a general meeting express itself satisfied,—first, that the variety is really a new one—and, secondly, that it is equal in value to Hunter's variety. 4th, At least two bushels must be produced in competition, which quantity is to be placed at the disposal of the Society for the purpose of making trials. 5th, These trials will be conducted under the superintendence of a committee to be appointed by the Society, and to report as often as the Society shall require for its satisfaction on the points mentioned in clause third.”

The handsome premiums for seedling wheats brought forward no competitors, which may be

attributed to the hostility which had been shown to the scheme, or perhaps to its author, thereby holding out the prospect of vexatious opposition to any member entering upon such a course of improvement. But I did not at the time, nor do I now, regard my endeavours to induce the Society to attempt improving the cereals as altogether barren of results. The agitation of the subject and my previous good fortune in this department presumably led Mr Robert Hope to gather from a whinstone quarry the seeds of a plant from which the variety known as Fenton wheat was raised. About the same time, and probably from a similar impulse, Alexander Douglas, farm-steward at Drem, culled on the harvest-field the beautiful ear which was the origin of Hopetoun wheat. To both of these varieties I may lay some claim, however small, without being charged with overweening conceit, as fruits of my proceedings before the United East Lothian Agricultural Society. Previous to this period the only recorded attempts to improve the wheat plant in East Lothian had been made by Mr William

Mackie, tenant in Ormiston, some time after the middle of the last century.

It has already been stated that my first step in attempting to promote the improvement of the cereals was a proposal to give premiums for new varieties. It was a singular coincidence, and perhaps unforeseen to each other, that Mr Robert Hope and myself were to be competitors for this premium, the one with Hopetoun and the other with Fenton wheat, both individuals being awarded a premium in this line of improvement—Mr Hope's application for the premium and description of Fenton wheat being dated October 1841.

The Highland Society's premium for new plants was at first a silver medal worth about 7s. 6d. or 8s., and it was changed into a gold medal or ten guineas, as might be preferred, the conditions of competition being also changed. There was also a medium gold medal or £5, 5s., usually given when the plant or the essay referring to it was considered to be inferior. My first competition for this premium was with Mungoswells wheat, to which the silver medal

was awarded, followed by the gold medal to the report on the Hopetoun variety in 1832.

Application was made in 1859 for a premium for new farm plants with Shirreff's Bearded Red wheat, and in doing so I called upon the secretary of the Highland Society, Mr Maxwell, whom I found setting out to join a business meeting of the board of directors in Edinburgh. Mr Maxwell invited me to accompany him to the meeting, in order that I might afford any information the gentlemen might require—putting my essay on the wheat into his pocket, while I walked by his side carrying a specimen of the plant on full-length straw. During my short interview with the committee of directors, I heard Mr George Harvey, Mr George Hope, and Mr Scot Skirving named a committee to consider and report on my application for a premium. On the secretary informing me that I would hear from him when the gentlemen made their report, I left the meeting.

The first information I learned regarding the fate of my essay was from a paragraph going the round of the newspapers to the effect that I

had been awarded the medium gold medal for a new variety of wheat. When satisfied of the truth of the award, as stated in the public prints, the secretary was informed that my essay had been laid before the Society in competition for the gold medal, and that the medium gold medal or half-premium which had been awarded to me was respectfully declined, and I begged to withdraw my report. On being asked to qualify my essay for full premium, I consented to do so on condition of seeing Mr Hope's report on my essay, for I knew it was his individually, or learning through the secretary Mr Hope's views on the subject, which were withheld.

The following excerpt from one of Mr Maxwell's letters to myself contains all the information on the subject I could obtain from him: "I regret that you are dissatisfied with the decision in regard to your report. It was remitted to a committee of three members, and the full premium was withheld, on the ground that the paper did not, as required, institute a comparison between the new wheat and a well-known variety;" and this view of the premium was

afterwards corroborated by Mr George Hope in a letter to myself.

Having received many first-class premiums for new cereals, I felt some anxiety to learn the defects of my essay on the present occasion. The following excerpt from the Society's printed premium-book shows what were the terms of competition. "For an approved report on the means successfully employed for obtaining new and superior varieties of any of the cereal grains, or roots, or other agricultural plants, the gold medal or ten sovereigns.

"It is necessary that the varieties or sub-varieties reported on have been proved capable of reproduction from seed, and also that the relation they bear to others of well-known sorts should be stated. The reporter is further required to mention the effects that he may have observed produced by different soils, manures, &c. &c., on the plants forming the subjects of reports, and how far he may have observed such effects to be lasting."

The following excerpts, from my report to the Society on Shirreff's Bearded Red wheat, will

show the nature of the document criticised and virtually rejected by Mr G. Hope :—

“The improvement of plants is interesting to the agriculturist and the gardener, whether the object of cultivation be intended to delight the senses or to feed the human race ; and the cereal grasses are so important to the population of Britain, that their improvement ought to form one of the leading objects of agricultural associations.

“Man possesses but little control over the cereals. However skilful the farmer may be in the preparation of the soil and in the application of manures, he can effect no lasting change on any variety of the cereals. The wheat plant, which is represented in the relics of some of the nations in the East, is the Egyptian variety (*Triticum compositum*) of the present day ; and there is no evidence to show that the oldest variety in British agriculture has undergone a change in any respect.” “It may be true that some of the kinds which have recently been introduced may be superior to those which were formerly cultivated, but the excellences of such varieties were stamped by nature at their

origin; and it may with safety be stated that there is no way of improving the cereals but by cultivating new varieties." "In order to carry out the views of improving the wheat plant, which I had found to be attended with success, a collection of wheats was made in 1856 containing named varieties, as well as sports which I had personally selected in different counties of England and Scotland, numbering seventy sorts, which were sown in the autumn of that year. After the harvest of the following year, half-a-dozen of the finest samples of red wheat in my collection were placed before three practical men in distinctly-numbered wine-glasses, and there was a unanimous opinion in favour of the grain in a certain glass as being the best in quality. The grains of crop 1858 were subjected to the like ordeal by the same individuals, and again an award in favour of the wheat which was considered the best in the previous year was made. This variety forms the subject of the present report.

"This wheat was selected in 1856 from a field of Hunter's on the farm of Tynefield, in the

parish of Dunbar, East Lothian. The ear is long, with red chaff, which is furnished with a stout beard. The straw is of considerable length, elastic, wiry, and often tinged with pink on the plant reaching maturity. The grain is long, large, and red. The variety is a true winter wheat, and unquestionably new in the agriculture of Scotland.

"This variety resembles the well-known Red Lammas in size and quality of grain, as well as in the general appearance of the crop when growing, and the grain is not inferior to any variety of red wheat cultivated in Britain. Upwards of fifteen acres of land have been sown during the present month for crop 1860."—Haddington, 15th Nov. 1859.

Reporting on new agricultural plants not being a hackneyed subject, another report, not without interest, will be given—viz., that on Fenton wheat:—

"To the Committee of the United East Lothian Agricultural Society.

"Gentlemen,—In the year 1835, having picked up a stem of wheat which was obviously different

from Hunter's, or any of the other varieties generally grown in the county, and having sown it yearly since, an opportunity has this year been embraced of ascertaining its relative value compared with Hunter's on two fields—one after plain summer fallow, and the other after beans. The result has been that the new variety, which may be called Fenton wheat, has in both instances exceeded Hunter's after fallow 7 bushels, and after beans 9 bushels, an acre, Scotch measure—the quality and weight per bushel being also rather in favour of Fenton wheat. The weight of straw per acre would be nearly the same. Fenton variety for 24 stones of straw gave 18 stones, Hunter's for the same quantity of straw gave 15 stones, of wheat.

“The appearances of the Fenton wheat when growing may be described as much firmer in the straw, and, if anything, rather closer set than Hunter's, while the grain is very much alike in every respect.

“Being anxious to know how it answered the baker, three bolls were sent to Mr Craven, Dirleton, who, after making it into bread by

itself, reports: 'I think you will be quite safe in sowing your wheat; it makes as good a loaf, and gives to the flour much the same as Hunter's to the same weight of wheat.'

"I beg to offer this in competition for No. 7 of the extra premiums.

(Signed)

"GEORGE HOPE,
for ROBERT HOPE."

When I first made application to the Highland Society for a premium with a new cereal, the conditions of competition included "that satisfactory evidence will be required that the plant is new in the cultivation of the country, or the uses to which it may be applied, and congenial to the soil and climate of Scotland." Such evidence could not be furnished by my own experience, but it was sought and obtained from kind friends residing in different parts of the country who had grown the new variety. In this manner it became necessary that my reports should be accompanied by testimonials of the plant "being new, and congenial to the soil and climate of Scotland," thereby creating in some cases more

expense for postages than the money value of the premium. When the conditions of competition were altered, testimonials were no longer necessary; but I generally appended them to my reports, as being better evidence of the nature of the plant than my own perhaps too sanguine impressions.

In the case of Shirreff's Bearded Red wheat now under consideration, no testimonials accompanied my report to the Highland Society, because the conditions of the premium did not call for such evidence. Yet even in such a restricted sphere evidence of the worth of the plant was not wanting. It was stated in the report that six samples of red wheat, which had been grown and treated under a parity of circumstances, had been submitted to the inspection of persons who were unanimous that Shirreff's Bearded Red was the best in quality in two successive years. One of the jury was Mr George Hope, who has no reason to feel ashamed of the opinion he first formed of the quality of the grain, as may be learned from the following documents:—

"MYLES, TRANENT, 1st October 1863.

"DEAR SIR,—In answer to your inquiries as to the results of an experiment made by me on the farm of Myles, between Browick and Shirreff's Bearded Red wheats for crop 1863, I have to state that both wheats were sown on the same day, 20th November 1862, and treated in every way similar.

"I considered the Browick by far the best all through the season, and expected a much better yield ; and it was not until both were threshed out that I found my judgment had been premature, as the Shirreff's Bearded turned out from two to three bushels per acre more. Besides this difference of yield, there was also a difference in the quality and price of the wheats, which were sold on the same day (20th April 1864) in Edinburgh market for milling purposes. Browick, weighing 18 stone 4 lb. gross, sold at 37s. per quarter. Shirreff's, 18 stone 9 lb. gross, sold at 40s. per quarter, and had three customers for one the other had.

(Signed) "JAMES STENHOUSE.

"Mr P. SHIRREFF, Haddington."

"STEAM-MILLS, MUSSELBURGH,

14th September 1863.

"DEAR SIR,—During the last twelve months I have ground a considerable quantity of Shirreff's Bearded Red wheat, and consider it for milling purposes the best red wheat of Scotch growth in our markets.

(Signed) "JOHN INGLIS.

"Mr P. SHIRREFF, Haddington."

"At the Birmingham and Midland Counties exhibition of cereals for 1863, open to all England, Shirreff's Bearded Red, grown in Essex, obtained the first prize in the class of red wheats, and Nursery Red the second."

From a lengthy correspondence which appeared in the 'North British Agriculturist' newspaper at the time, it is made evident that the members of the committee which were appointed by the directors of the Highland Society to consider and report on my application for a gold medal, never met for the purpose they were appointed ; that two members of the committee had signed no report ; and that the third one,

Mr George Hope, had, unknown to his colleagues, set them aside, and reported to the secretary of the Society his own views upon my essay. Although the report alluded to was never published, its animus and pretended misconceptions of its author were made obvious by a letter Mr G. Hope addressed to myself, from which the following is an extract: "My difficulty, as your paper stood, was in giving even the medium gold medal, as far as the decision stamped the approbation of the Highland Society on a variety of wheat which, on actual trial, might prove worthless; and it was only your previous valuable contributions to practical agriculture which overcame my scruples."

The stratagem of disregarding the real and acting on fictitious conditions of premium, so successfully carried out in the case of the East Lothian Agricultural Society, was again followed in the present instance. The slightest consideration of the conditions of the premium ought to have satisfied Mr George Hope that the Highland Society's medal was not given for a variety of wheat, nor for any part of

a plant, nor yet for instituting a comparison of any kind, but "*for an approved report on the means successfully employed for obtaining new and superior varieties of any of the cereal grasses.*" Although having been deprived of an honorary reward by a somewhat ingenious artifice, I have since obtained from the Highland Society several gold medals for reports on new cereals, without altering the plan of my reports or being asked to institute a comparison, the conditions of premium all the while being unchanged.

To many individuals the obtaining of improved cereals may perhaps appear to be a simple matter, requiring little more than the examination of growing crops, and selecting the ears of the plants most fancied. But the outward appearances are no guide to the properties best suited for farm-crops. Two plants externally alike in all respects may inherit different principles, which nature alone reveals in the progress of vegetable life. The species of winter and summer wheat cannot be distinguished by examining their seeds; and varieties of the same species apparently identical may differ in

shedding their seeds in wind, and in their sprouting in wet harvests. It will be found that a knowledge of the wheat plant is not likely to be attained without considerable observation and reflection.

In carrying out the improvement of cereals, the selecting of varieties may be considered an important step; and the object in all probability will be sooner accomplished and better controlled by first creating a diversity, which can be easily effected by crossing. Natural sports or varieties selected from a well-marked kind, will almost always be found to inherit some of the characteristics of the parent stock, or, in botanical phraseology, partake of the same strain; and a high-class white wheat need not be expected to originate amongst such coarse red varieties as the Rivets and Spaldings. Crossing tends to produce variation in kinds not given to sporting, and in this respect it has much advantage over the system of improvement by merely selecting from the crops of the farm. A new and important source of variation is opened up by crossing, and a judicious improver of the

cereals will never overlook this interesting proceeding. Always cross with the seedlings which inherit in the greatest degree the properties you wish a cereal to possess ; and by persevering for a series of years to select and to cross in this manner, success in all probability will be ultimately attained.

There may be different ways of getting sports or hybrids from wheat. Mr Knight thinking that nothing more is necessary than planting two kinds together, I have used pollen of two kinds mixed together for hybridising, but without success ; I have also attempted unsuccessfully to bud a young shoot of one variety upon the stool of another in spring, the chief cause of failure being the unsteadiness of my hands in old age.

In the spring of 1871, I prevailed upon a young friend, A. Stewart MacGregor, to cross Victoria bere or big with the pollen of Chevalier barley. I was informed that several seeds were obtained, but that all the plants from them died when young. But I do not consider these cereals to be so distinct in character as to prevent

them crossing, and hope successful attempts will yet be made to attain this object. The barleys of Britain are found to be defective in length and strength of straw, more especially in cattle-keeping districts; and whoever succeeds in combining the stout and long straw of Victoria bere and the fine grain of Chevalier barley on one plant, will be a benefactor to his country.

The improvement of the cereals would in all probability lead to the enlargement of the corn-growing area of Britain, if not to an amelioration of her whole agricultural system. With earlier cereals than are now grown, the cultivation of them would spread to higher altitudes, thereby increasing their extent. In this movement the different species of cereals might retain nearly their present proportionate size. As the surface suited for the growth of wheat increased, so would that for barley; while the cultivation of the hardy oat would be found encroaching on the home of the grouse and the deer. With proper management, this addition of arable surface would produce suitable green and pasture crops alternately with the cereals,

to an increase of the vegetable and animal products of the nation. For the attainment of such an end there is no want of enterprise, skill, and capital in the country, which ought to be set in motion by the present ill-directed funds of agricultural associations, whose members are fully alive to the advantages of early maturity in connection with the animal kingdom, while paying little attention to it in the vegetable tribes. Hitherto agricultural societies have done little to improve the cereals, and nearly the whole rural population seem to be indifferent to such an object. In this age of investigation and intelligence, it is surprising to find that only a very small percentage of corn-growers are aware that the cereals possess both the sexes in one blossom, through which alone they produce seeds.

THE WHEAT-FLY.

WHEN unaware of the existence of the wheat-fly, my introduction to the insect and its devastations were purely accidental. On returning to Mungoswells in the month of June 1827, after an absence of several weeks, I strolled into the fields to see what progress the crops had made in the interval. The evening was calm, at the close of a brilliant sunset, and the wheat-ear, which was in the stage of bursting the sheath, formed the most attractive portion of the crops. I observed for the first time multitudes of small yellowish-coloured flies infesting the ears, but anticipated no evil from such diminutive creatures. Later in the season, on examining how the filling of the ears was progressing, many of

the capsules were found to contain a number of maggots and no grain. At this time the small flies, formerly so numerous, were no longer to be seen, and I resolved to investigate next season if there was any relation between the flies and the maggots. In 1828, while under the impression of the wheat-fly being a new discovery, my first notice of the insect appeared in the magazine of Natural History, published in London, and edited by John Claudius Loudon. In the following year my further observations were published in the East Lothian Journal, and from this source the following details are chiefly derived.

The first scientific description of the wheat-fly appears to be due to Messrs Kirby and Spence, whose account of the insect appeared in the third volume of the London Linnæan Transactions for 1785. But long before this period the devastations caused by the insect had been noticed by persons who appear to have been unacquainted with the insect itself. Somewhere about the year 1703, Mr Leslie wrote thus: "Where in wheat flowering time there are more cells in a chest that blossom, they can better maintain the

loss by all accidents that may happen. For instance, if one or two fail in flowering time by a fly-blow (it being often the case), there are blossoms enough to make good the loss by maintaining three good grains in a chest." Ellis of Little Gaddesden, Hertfordshire, in his 'Month of August,' writes in 1740: "This year the Thames was frozen by a two months' frost, and an ox was roasted whole upon it." "After this we had a melancholy sight, for as soon as the wheat had done blooming, vast numbers of small black flies attacked the wheat-ears and blowed a little yellow maggot, which ate some of the kernels, and others part of them, and caused multitudes of the ears to miss of their fulness, acting in some measure like a kind of locust, till rain fell and washed them off; and though this evil has happened in other summers to the wheat in some degree and not done much harm, yet if the good providence of God had not hindered it, they might have ruined all the crops of wheat in the nation." It is evident from the last extract that Ellis had mistaken the little black ichneumon, the greatest destroyer of the

wheat-fly young, as the parent of the maggot—an error which has often been committed since.

In East Lothian, the wheat-fly of the present day has a yellow or orange body, with pale grey wings, long legs and feelers, and in general appearance resembles a midge or gnat. The male, which is seldom seen, is of deeper orange than the female, with a thicker body and wings more iridescent. The female is furnished with a long hair-like ovipositor, which can be extended or withdrawn, and is seldom seen but when eggs are being deposited.

The flies appear about the time the wheat plant comes into ear, living but a short time, and depositing in the flower of the wheat eggs that produce maggots, which destroy the grain or prevent its formation, and drop to the earth before the ripening of the crop. In the following spring the maggots undergo transformations, and come forth perfect insects. In this manner the wheat-flies are perpetuated from year to year. On issuing from the earth the fly soon finds out the wheat plant, even when growing in city gardens. During day the insect generally

reposes on the lower parts of the wheat crop, becoming industriously active a short time before sunset, but is quiescent during heavy rain, moderate wind, and bright sunshine. The eggs of the wheat-fly, which can be seen by the naked eye, are deposited in clusters on the curtain of the inner chaff-scale of the capsule; and with wonderful instinct the fly passes a thread from its eggs round the anthers, which are thereby retained within the capsule to supply pollen to nourish the young maggots, which are first translucent, but soon become yellow from feeding on the ripe pollen. Sometimes, however, eggs are deposited in different parts of the blossom, and both maggots and a grain have been found in the same capsule, and even with a smut-ball. Generally one side of the ear is more injured than the other by the wheat-fly, but sometimes the insect renders nearly the whole of the ear unfruitful.

The wheat-fly comes into life according to the action of solar heat upon the pupa in the soil, and it is found latest on the spring-sown portion of the crop. In 1829, flies were first noticed by

me on the 21st of June, their eggs on the 23d and the insect disappeared towards the middle of July. The following excerpts are from my note-book of 1871: "June 10th—wheat-flies first seen to-night." "June 11th—flies more numerous. Two or three varieties of wheat are sufficiently advanced to receive the eggs of the fly." "June 17th—flies innumerable; forty-three counted upon one ear at the same time. During a heavy fall of rain all the flies disappeared from the ears of wheat, and returned to them when the shower ceased." In 1872, wheat-flies were noticed for the first time on the 29th of June, and in great numbers on the 4th of July; and were noticed so late as the 23d of the same month depositing their eggs on the late wheat-ears.

It has been said that no person has succeeded in hatching a wheat-fly. When first occupied in investigating its habits and transformations, several maggots of the wheat-fly were put into a pot of earth in the month of March and placed in the sitting-room at Mungoswells. On searching the pot for maggots in June following, a

pupa was discovered enveloped in a thin transparent membrane, through which the large black eyes and the feelers of the wheat-fly were distinctly visible. When in the act of getting a lens for the better observation of the object, a current of air, caused by an unexpected opening of the door, carried off the table at which I was seated a sheet of paper on which the pupa had been placed ; and my hopes of hatching a wheat-fly, when on the point of being realised, were thereby accidentally blasted.

After seasons of extensive injury by the wheat-fly, I have seldom experienced much difficulty in finding its maggots in clods in the fields of ploughed lands, which had previously been a wheat crop. On such a field I found the maggots on the 7th June 1855, when they appeared but little changed since leaving the ear in the previous autumn. On the 14th of the same month the examination was repeated on the same field, with a like result ; and again on the 21st, when no maggots were found. The transformation from the maggot state to the perfect insect seems to have been going on from the 14th of June, and

I observed flies on the wheat crop towards the end of the month. On the flies emerging from the pupa into the fly form, they seek suitable shelter, and have been found crowded on the under side of the leaves of the charlock growing on a fallow field, which had been a wheat crop in the previous year ; and it is most probable that then the union of the sexes takes place, before the females set out in search of the wheat plant, as a *nidus* for their young.

When the wheat crop is reaped before being ripe, some of the maggots are shut up in the capsules of the ears, and most likely perish there without becoming flies. In manipulating specimens of ears in the months of October and November, I have occasionally found maggots alive, and bright in colour. Suggestions have been made for getting rid of the wheat-fly's devastations, but none of them are practicable enough to merit much consideration. The growing of very late or very early crops of wheat may perhaps be found to lessen the evils of the insect ; but for pests of this description nature generally provides a remedy by creatures preying upon

one another. The chief scourge of the young of this fly is a small black ichneumon, which resembles a winged ant, and which deposits its eggs in the maggot's body, and the young of the ichneumon destroys the young of the wheat-fly. This ichneumon was mistaken by Ellis of Gaddesden for "the fly which blowed a little yellow maggot;" and many people afterwards fell into the same mistake. It hunts over the ears of wheat for maggots, depositing eggs in their bodies. On fine evenings, I have on the palm of my hand placed the larvæ of the wheat-fly, and there witnessed the ichneumon deposit eggs upon the larvæ of the wheat-fly. But several other insects also prey upon the larvæ of the wheat-fly. Observing an earwig on a fine evening to be searching an ear of wheat, I presented successively, on the point of a straw, three of the larvæ of the wheat-fly, which it devoured greedily.

The disappearing and reappearing of insect pests are mysterious. So early as 1703, the devastations of the wheat-fly were noticed in Britain by Mr Leslie; but its greatest injuries

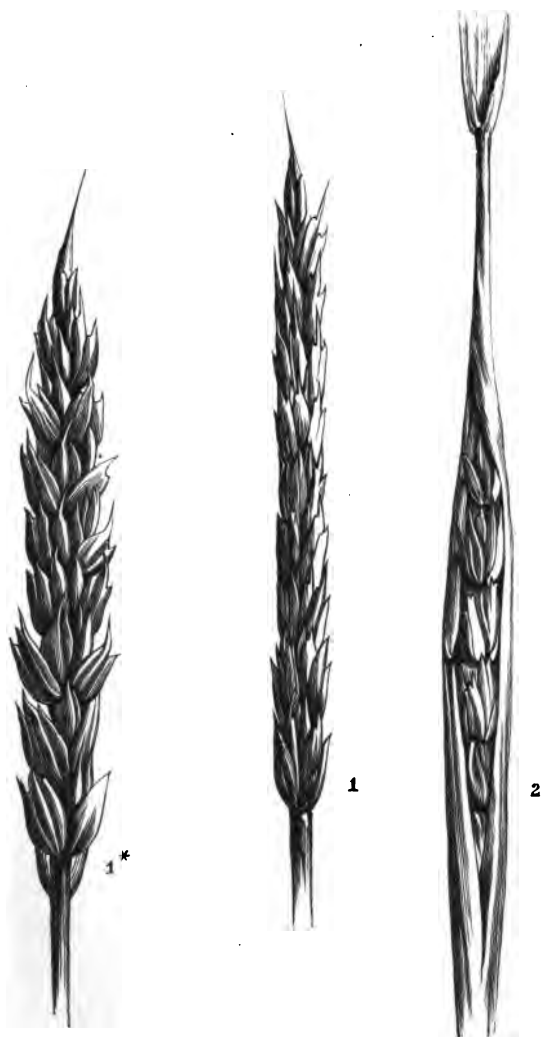


PLATE IV.—1*, Ear from nature; 1, Opposite side of same ear destroyed by the wheat-fly; 2, Ear bursting the sheath.

have been experienced in the Dominion of Canada and the United States of America. In East Lothian, in 1870, I could scarcely find a specimen of the wheat-fly in the height of its season; but in 1871 its ravages were pretty extensive in the early portions of the crop in the lower districts of the county, while the late wheat crops were uninjured. The fly has not been observed to prefer one variety of wheat to another as a breeding-place, when the ears are at the same stage of forwardness; and the spikes of the common couch-grass, *Triticum repens*, are as readily chosen by it as the wheat of the farm. But while apparently indifferent to the variety of wheat, much partiality is shown by the fly for ears in the first stage of bursting the sheath, eagerly depositing its eggs in the side first accessible, to the neglect of the other side. This habit of the wheat-fly accounts for one side of the ear being so often found to be seedless, and the other side filled with grain.

From the wheat-fly being small, faint in colour, and appearing chiefly about sunset, few people have noticed it, and many farmers disbelieve in

the existence of this pest of the wheat crop. But persons who will take the trouble to investigate for themselves, can see the fly deposit its eggs in the capsule of the plant, and the eggs to produce maggots, which prevent the formation of the grain ; and they may as reasonably deny the existence of the flesh as the wheat-fly.

It has been stated that the ravages of the wheat-fly can to a certain extent be mitigated by sowing quick-blooming varieties, a property not generally recognised by practical farmers ; and perhaps it was first noticed in Morton's 'Cyclopædia of Agriculture.' At page 1120 of that work, the following description of Hopetoun wheat is given : " Its characteristics are long, stiff, bright-coloured straw ; more than average length of ear, which runs a little to a point ; smooth chaff, free from awns ; grain plump and transparent, producing a beautiful sample, weighing well in the bushel. The crop is seldom so prolific as its appearance when growing would warrant. It is rather tender in constitution, and being tardy in completing the process of blooming, it is very liable to be injured, in consequence

of the wheat-fly having a long time to deposit eggs while the blossom is opening the chaff-valves." It has already been stated that the wheat-fly deposits its eggs in the capsule as soon as the first portion of the ear bursts the sheath, and that the insect also prevents the expansion of the blossom by fixing the anthers within the capsule with a glutinous thread. The wheat-fly thus completes its measures for breeding at the earliest stage the ear can be reached by its ovipositor, and therefore its success or failure in propagating its species is not likely to be much affected either by quick or slow blooming varieties of wheat, if such exist. The ear is not first seen shooting from the top of the sheath, but it bursts the curtains of the sheath some inches lower down, and thus one side of the ear becomes accessible to the fly several days before the other side. From choice, the wheat-fly deposits eggs in the capsule when the valves of the chaff adhere pretty closely, and the insect turns aside from ears with advanced blossom and open chaff-valves. It will now be shown that Hopetoun

wheat is not tardy in completing the process of flowering.

To ascertain some of the flowering peculiarities of wheat, I sowed a few varieties experimentally on the 22d February under a parity of circumstances, and they came into ear at the following dates: Talavera on the 10th July; Archer's Prolific and Todd's on the 16th; Gregorian and Hopetoun on the 18th; Fenton on the 19th; and Rivet on the 25th July. On the 22d July, ears in the same stage of forwardness of the six first-mentioned kinds were selected and marked; and with all of them the hulls of the anthers appeared on the outside of the chaff on the 27th July. The Rivet not being in ear on the 22d July, one ear of this variety and one of Fenton were marked on the 27th; and both ears showed the hulls of the anthers on the outside of the chaff on the 2d of August. The tardy blossoming of Hopetoun wheat is an ingenious fiction, which, by means of cyclopædias, may be handed down from generation to generation, until it becomes an article in the creed of the farmer.

Rivet wheat, from being later than any variety usually cultivated in Scotland, often escapes the ravages of the wheat-fly, and in consequence it was known at one time by the name of Anti-fly wheat. In East Lothian the wheat-fly is a prominent, but not the only, cause of unfruitfulness in wheat-ears.

APPENDIX.

The weather of 1872 so affected my experimental wheats, that a collection of crosses, forty-two in number, and in the third year of their reproduction, could not be distinguished from each other by the shape or colour of their seeds, which appeared to be mere skins. Being reluctant to lose a collection in which I took considerable interest, the abortive-looking seeds were sown in rows on the 4th November 1872. But from the altered state of my health, my experimental plot was not often visited.

On the 19th December, I found all the wheat above ground and thickly planted, with exception of four or five varieties, and even these would prove thick enough if the plants survived the winter. But soon the plants began to disappear day by day, until some rows were almost left without a plant. A few tender seed leaves